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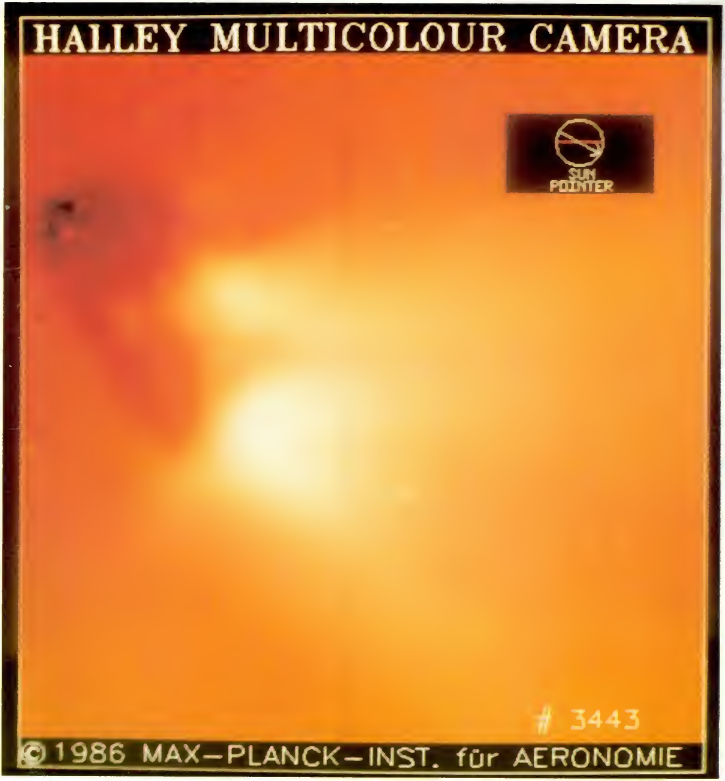
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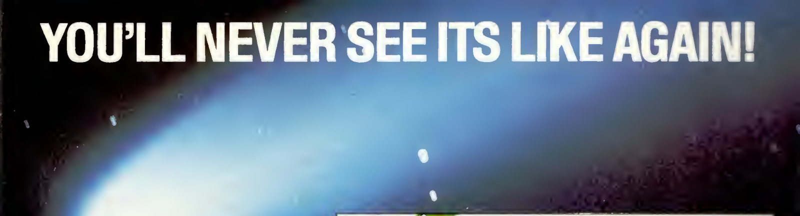

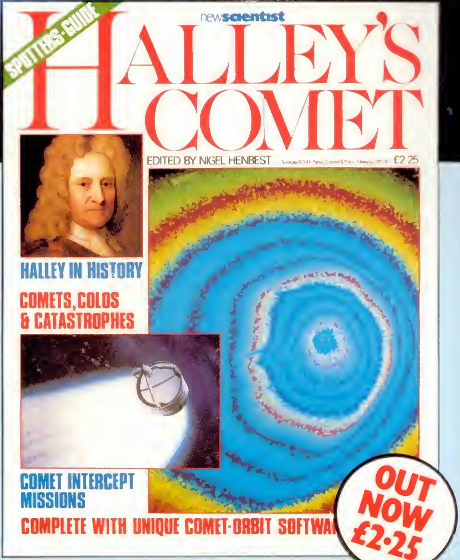

newscientist
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Bill Sanderson

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Flexible working arrangements will be essential, engagement may be on a part-time or full-time basis during the financial year and will often be of short duration (a week or less). Most of the work will demand quick access to offices in Lewes and in some cases work within the County Planning Department, which will be the work base.

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3. *Landscape Clerk of Works with project supervision*
4. *Ecology*
5. *Agricultural Economics*
6. *Forestry/Arboriculture*
7. *Environmental Pollution*

Some of the work may be of interest to Landscape Architecture 'year out' students with flair and flexibility. Some will require full Landscape Architectural and Horticultural skills.

Anyone interested in this work should write to the County Planning Officer, East Sussex County Council, Southover House, Southover Road, Lewes, with CVs and terms of engagement. If further information is required please contact Nigel Marshall or Bill Lanning on Lewes (0273) 475400.

UNIVERSITY OF DUNDEE

Department of Biological Sciences

Applications are invited for a

RESEARCH ASSISTANTSHIP

to work on the molecular biology of cyanobacteria. The person appointed should have an Honours BSc in a relevant biological discipline. Appointment will be for one year with a salary of £6600 on the 1B range. Further details may be obtained from Drs N. Kerby or P. Rowell, Tel (0382) 23181. Applicants should send a full cv, with the names and addresses of two referees to the Personnel Office, The University, Dundee DD1 4HN by 5 April, 1986. Please quote Ref EST/415/86H.

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Applicants will be expected to possess a first degree in a biological science and, preferably, will have a post graduate qualification in toxicology and/or a minimum of 10 years experience in toxicology with at least 5 years spent in inhalation toxicology. Previous managerial experience will be considered a distinct advantage. Ability to work independently while retaining responsibility for the integrated operation of the Unit is essential.

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Due to continuing expansion the Department of Mutagenesis and Cell Biology requires a Scientific Officer to join a team conducting short-term mutagenicity tests.

The main role will be to assist in the supervision, performance and reporting of mammalian cell studies.

The successful applicant will receive training and experience in both cytogenetic and cell mutation assays.

Applicants should have an honours degree in a biological science, or equivalent, and experience in cell culture techniques would be preferred.

Temporary Scientific Officer

A cell biology graduate is required to participate in research and development into *in vitro* cell culture systems (both mammalian and non-mammalian) for the eventual assessment of chemical toxicity.

Applicants should have an honours degree in a biological science and should preferably have experience with primary and/or established cell lines. A knowledge of *in vitro* immunology techniques would be an advantage.

Initially this is a temporary position while the present job-holder is on maternity leave.

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Research at University of Edinburgh

ARTIFICIAL INTELLIGENCE AND SPEECH

A major five-year Alvey-funded research and development project in automatic speech recognition started at Edinburgh in October, 1984. The project, which is carried out by the Departments of Artificial Intelligence, Electrical Engineering and Linguistics, is applying Artificial Intelligence techniques in the design and implementation of a machine-assisted speech transcription system.

Computing resources include a Vax 11/750 running Unix (TM Bell Laboratories), a Masscomp 500 and a network of Xerox 1108/1109s AI workstations running Interlisp-D. The eventual target system is a parallel reduction machine now under development in a related Alvey project.

We are now seeking seven new staff with academic or industrial backgrounds, with experience in one or more of the following areas: computational linguistics, acoustic phonetics, expert systems, signal processing, LISP, C/UNIX.

Candidates should preferably be postdoctoral or have relevant industrial experience. Starting salaries range from £9495 to £15 700.

For further details of the available posts, phone (031) 225 8883, Ext 273, or write to Mr H. Blackburn, Administrative Manager, Centre for Speech Technology Research, University of Edinburgh, 80 South Bridge, Edinburgh EH1 1HN. Please quote Reference No 1600.

OXFORD POLYTECHNIC COMPUTER CENTRE

Applications are invited for a new post within the User Services Group for supporting the Faculty of Technology. Applicants should have a computer programming, or systems background, and will now be wishing to develop a career encouraging and supporting the use of computers across the departments of the Faculty. A post A-level qualification, and two years work experience will be desirable.

The post will be graded on Scale 4-6 (£6900-£9591) or SO1-SO2 (£9975-£11 604) according to experience.

Further details can be obtained from the Staffing Office.

Department of Mathematics, Statistics & Computing

SERC CASE Studentship in Computational Plasma Physics

A postgraduate studentship is available to carry out research on the behaviour of high temperature plasmas using mainly computational techniques. The studentship is funded by the SERC in collaboration with Culham Laboratory, is tenable for three years, and the work will form the basis of a MPhil/PhD higher degree of the Council for National Academic awards. The subject of research is the confinement, equilibrium and heating of toroidal plasma in magnetic fields, in particular the magnetic field structure internal and external to reversed field pinch plasma. The work will be mainly computational in close co-operation with experimental and theory groups at Culham Laboratory with access to a range of powerful computers.

The basic SERC grant is currently £2665 plus CASE supplement of £650 minimum, and can be supplemented by some academic duties. The post will normally be available from September 1986.

Further details and application forms are available from: The Postgraduate Tutor, Department of Mathematics, Statistics & Computing, Oxford Polytechnic, Oxford OX3 0BP.

UNIVERSITY OF HULL
Department of Biochemistry
POSTDOCTORAL RESEARCH ASSISTANT

Applications are invited for the above post, funded under the ICI Joint Research Scheme, to work on the production of novel polymers by micro-organisms. The project is designed to (1) investigate systematically the range of polymeric materials related to poly-β-hydroxybutyrate which can be synthesised by different micro-organisms; (2) study the regulation at enzyme level of poly-β-hydroxybutyrate synthesis in Alcaligenes; and (3) investigate the specificity of key enzymes in the biosynthetic pathway to improve understanding of how copolymers are made.

Applicants preferably should have some experience of microbial biochemistry, physiology and enzymology, and experience of chemostat operation would be an advantage.

The post is tenable for three years and the starting salary on the 1A scale will be up to £8379 pa.

A Grade IV technician will also be employed on the project.

The department is well-equipped with a Fermenter and Chemostat Suite and supporting services.

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UNIVERSITY OF EAST ANGLIA
Norwich

RESEARCH ASSOCIATE

Applications are invited for the post of Research Associate in the School of Chemical Sciences, funded by the Ministry of Agriculture, Fisheries and Food, for a collaborative project to develop methodology for the determination of potential contaminants of the food chain. The work will involve the use of modern instrumental techniques including chromatography and mass spectrometry. Applicants at postdoctoral or graduate level should preferably have experience in one of the following areas: trace analysis, chromatography, mass spectrometry or environmental measurement. The salary will be at the appropriate point on the Research Associate scale (£7055-£12 780 per annum), depending on age and experience. The appointment will be tenable for two years in the first instance.

Applications, including a cv and the names of two referees to Dr C. Creaser, School of Chemical Sciences, University of East Anglia, Norwich NR4 7TJ.

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BIOSIS, UK
Garforth House
54 Micklegate
York YO1 1LF

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THE UNIVERSITY OF LEEDS
DEPARTMENT
OF CIVIL ENGINEERING

POSTDOCTORAL RESEARCH FELLOW

Applications are invited for the above post from candidates holding a PhD degree in Civil Engineering, Materials Science, Physics or Chemistry, to carry out research into the use of chemical membranes for curing concrete. The project, which is supported by SERC, involves a laboratory investigation of various chemical membranes to protect concrete during curing. Study of the mechanisms of water transfer through the membranes will be an important part of the work.

The appointment will be for a fixed period of up to three years on the IA Range for Research and Analogous Staff (£8020-£12 780) (under review), according to age, qualifications and experience.

For further information contact Professor A. R. Cusens (Tel (0532) 431751 Ext 265).

Application forms and further particulars may be obtained from and completed applications sent to the Registrar, The University, Leeds LS2 9JT, quoting reference number 74/56.

Closing date for applications 10 April, 1986.

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For further details and an application form, please phone or write to our Personnel Department, PA Technology, Cambridge Laboratory, Melbourn, Royston, Herts SG8 6DP.
Telephone: Royston 61222.

PA Technology
Cambridge Laboratory

THE CAMPDEN FOOD PRESERVATION RESEARCH ASSOCIATION

Chipping Campden, Glos. GL55 6LD

LIAISON OFFICER

The Campden Food Preservation Association requires a Liaison Officer to co-ordinate education and training courses, compile information documents about the RA, arrange exhibits for Open Days and maintain the RA photographic collection.

Applicants should be able to communicate well at all levels, have good organising ability and a flair for presentation with attention to detail. Good written English is essential. Although a scientific background is not a pre-requisite it will be necessary to acquire an in-depth knowledge of the scientific operations of CFPRA in order to help the RA to communicate its activities to the food processing and allied industries worldwide.

Age: over 25. Salary: according to age, qualifications and experience.

Application forms and a job description are available from the Secretary-General, Campden Food Preservation Research Association, Chipping Campden, Glos GL55 6LD.

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Applications are invited for the following posts:

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Are required in the Production Department to operate large scale protein and carbohydrate purification equipment. Applicants should be educated to HNC/BSc in Chemistry/Biochemistry or a related discipline. Practical experience in preparative column chromatography would be an advantage.

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2. A Quality Control Technician

Is also required. Minimum requirements are HNC/BSc in Biochemistry, and a working knowledge of HPLC would be an advantage.

Applications including cv to:

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Sandling Road,
Maidstone,
Kent
ME14 2LE.

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Department of Medical Physics and Bioengineering

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The minimum qualification for a Grade II appointment is an ONC in Applied Physics or equivalent, together with several years appropriate experience. Higher qualifications are desirable. Other candidates may be considered for appointment at Grade III or Grade IV. The appropriate training will be given.

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As the post will involve working in six Districts, a current driving licence and use of a car is essential.

For further details, or to arrange an informal visit, please contact either Mr Michael Fitzgerald, Principal Physicist (Radiation Protection), Tel 01-672 1255, Ext 5038, or Mr Don Ritchie, Principal PMT, Ext 4058.

Application forms and job descriptions are available from the Personnel Department, St George's Hospital, Blackshaw Road, Tooting SW17 0QT, Ext 4121. Closing Date: 3 April, 1986.

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Whitley Council Conditions of Service.

For further information contact Mr J. Saunders, Tel 01-928 9292, Ext 2374/2674. Application Form and Job Description available from Personnel Department, Ext 3045. Closing date for completed application forms 4 April, 1986.

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UNIVERSITY OF WALES COLLEGE OF MEDICINE

Section of Dermatology

Department of Medicine

TWO BIOENGINEERING RESEARCH POSTS

are now available within the section. Successful candidates will join a busy, stimulating research and clinical group with an international reputation in biophysical measurements of skin.

The first post (Ref. No. M6/138) requires a research officer to assist in the design, construction and use of novel instrumentation for measurement of mechanical forces experience by skin in controlled laboratory and real industrial environments. The candidate should possess a degree or equivalent in an electronics/physics/engineering or related subject, and experience of electronics design and construction would be an advantage. This post is funded for two years on the University Research and Analogous Staff Grade 1B scale.

The second post (Ref. No. M6/142) is for a research officer to join a project to study the ultrasonic propagation properties of skin, with the aim of improving the presentation and interpretation of ultrasound images from skin. This candidate should possess a degree or equivalent in a technical subject, and a knowledge of ultrasound and/or computing would be an asset. This post is funded for an initial period of eighteen months on the University Research and Analogous Staff Grade 1B scale.

Further particulars and applications forms (quoting relevant reference number) available from the Registrar and Secretary (Personnel Office), University of Wales College of Medicine, Heath Park, Cardiff, CF4 4XN (Tel 0222/755944 Ext 2296). Closing date for application: 18 April, 1986

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ulis

HIGH MODULUS POLYMERS

ULIS (University of Leeds Industriel Services) Ltd, wishes to make contact with an experienced

RESEARCH WORKER

to work on high modulus polymers. The post will be for two years starting in July 1986, with the possibility of a further extension, and applications are invited from those with Research Engineer/Physicist qualifications. Salary according to age, qualifications and experience in the range £8020 to £12 780.

Please write giving details and two referees to Contracts Officer, ULIS Ltd, 175 Woodhouse Lane, Leeds LS2 3AR, marked "Confidential".

POLYMER SCIENTIST

World-renowned research institute requires a young graduate to work initially in the field of polymer blends. Candidates should have either a good first degree in either polymer science or materials science with a significant polymer element or a higher degree on a polymer-related topic. The successful candidate will work on both rubber/thermoplastic and rubber/rubber blends.

Apply to: The Director (quoting ref. CSLB), The Malaysian Rubber Producers' Research Association, Tun Abdul Razak Laboratory, Brickendonbury, Hertford SG13 8NL.

THE NEW SOUTH WALES INSTITUTE OF TECHNOLOGY
SYDNEY, AUSTRALIA

Equal Employment Opportunity is Institute Policy

FACULTY OF LIFE SCIENCES

SCHOOL OF BIOLOGICAL AND BIOMEDICAL SCIENCES

The School of Biological and Biomedical Sciences offers undergraduate degree programmes in Biomedical Science, Biotechnology, Environmental Biology and Urban Horticulture. The School also offers Masters degrees by coursework in Clinical Measurement and Environmental Toxicology, Masters degrees by thesis and a doctoral programme jointly with Macquarie University.

Applications are invited for two Lecturer positions:

LECTURER IN CLINICAL MEASUREMENT

Reference No. 86/051. Closing date April 10th, 1986.

Applications are invited from people with a sound knowledge of the design and application of modern instrumentation and computing systems as used in clinical and biological measurement. Appropriate experience in a relevant aspect of medicine or biology is essential.

The appointee will be expected to teach in the areas of bioinstrumentation and laboratory computing, and will be asked to participate in the further development of a Masters Degree course in Clinical Measurement.

LECTURER IN QUANTITATIVE ECOLOGY

Reference No. 86/055. Closing date April 10th, 1986.

Applicants are invited from ecologists who have a sound knowledge of the use of computers in the biological sciences. Experience in the areas of biometrics, biological modelling and remote sensing techniques would be an advantage. The appointee will be expected to teach computing to undergraduate biology students as well as participating in the environmental biology programmes.

Applicants should possess a doctoral degree and an appropriate research interest.

Further information may be obtained from Dr. Margaret Burchett, Head, Department of Applied Biology on (02) 436 6220.

Salary: Lecturer to $A35,777.

Applications for the above positions should include a detailed curriculum vitae and the names and addresses of three referees. These should be sent by the closing date, quoting the Ref. No., to:

The Director,
NSW Government Office,
66 Strand, LONDON, WC2N 5LZ.

6197

NATIONAL INSTITUTE FOR BIOLOGICAL STANDARDS AND CONTROL

Division of Antibiotics and Chemistry

TECHNICIAN/RESEARCH OFFICER—AC/161

A Technician/Research Officer is required to work on the physiochemical properties of complex carbohydrates as part of a more general research programme on their structure and biological activities.

In addition to a degree, applicants should have an interest and practical experience in physical organic chemistry.

Salary scale: £7092-£9561/£9975 inclusive pa. Staring point will be dependent upon age, qualifications and experience. (Only applicants with a minimum of two years related experience can be appointed direct to the Research Officer scale).

TECHNICIAN—AC/162

A technician is required to work on sequencing and amino acid analysis of medically important proteins and peptides. The successful candidate must have the ability to work with minimal supervision and have an interest in protein chemistry. Familiarity with protein analysis, chromotographic techniques (including HPLC) and an understanding of micro-processor controlled laboratory equipment would be an advantage, but not essential.

Applicants should be qualified to degree level or equivalent in Chemistry/Bio-Chemistry.

Salary is on the scale £7092-£9561 inclusive pa, dependent upon age, qualifications and experience.

For further details and an applications form, please contact the Personnel Office, quoting the reference number, National Institute for Biological Standards and Control, Holly Hill, Hampstead London NW3 6RB. Tel 01-435 2232.

Closing date for applications: 11 April, 1986.

ST MARY'S HOSPITAL MEDICAL SCHOOL

(University of London)

Norfolk Place, London W2 1PG

Department of Pharmacology

JUNIOR 'B' MLSO

required for the Drug Metabolism section of this busy department. Duties will include the preparation for practical classes and the general maintenance of research laboratories. There will be opportunities to participate in research projects where previous knowledge of HPLC and radiochemical techniques would be an advantage.

Minimum qualifications are two A levels in science subjects.

Salary in the range £4866-£6356 (including London Weighting).

Apply in writing with full cv and names and addresses of two referees to: Assistant Secretary (Personnel) at the above address by 3 April, 1986.

UNIVERSITY OF BRISTOL

RESEARCH ASSISTANT IN ORGANIC CHEMISTRY

A postdoctoral research assistant is required for participation in the synthesis of compounds with pharmacological action within the central nervous system.

The post is available for up to two years and a carries a stipend within the range £8020-£12 780, according to qualifications and experience.

Applications to Dr J. C. Watkins, Department of Pharmacology, The Medical School, University Walk, Bristol BS8 1TD.

MORE VACANCIES ON PAGES 67–87

Bio-analyst
A Senior Appointment

South Manchester **Attractive package + car**

SANOFI is the UK subsidiary of a major international pharmaceutical company trading in this country as LABAZ.

Due to an extensive and expanding clinical research programme in the UK and overseas, we now wish to establish a bio-analytical unit providing drug analysis for clinical trials and require an enthusiastic and highly motivated bio-analyst to set up and run this function.

Initial responsibilities will include the selection of equipment for the new laboratory, recruitment of staff and the establishment of GLP procedures. Thereafter, the successful applicant will be responsible for the installation, validation and running of analytical methods, as well as the provision of reports to the Medical Department. Close liaison with our French parent company will form an important element of this work, resulting in occasional overseas visits to Sanofi's analytical laboratories in Southern France.

This highly responsible appointment requires a senior bio-analyst, aged 28-35, with extensive industrial experience in analytical chemistry or bio-analysis, together with a sound theoretical background and several years' practical experience in modern analytical instrumentation, particularly automated HPLC. Applicants should be experienced with computer-based instrumentation control and data management. A basic knowledge of pharmacokinetics and drug metabolism would be a useful asset.

Excellent conditions of employment are offered including a salary commensurate with this senior appointment. Relocation assistance, where appropriate, will be provided. The Company is located south of Manchester on the Cheshire border within easy access of a comprehensive motorway network.

Please write, enclosing full personal and career details to Miss L White, Personnel Officer, Sanofi UK Limited, Floats Road, Wythenshawe, Manchester M23 9NF.

sanofi

Department of Geological Sciences

Lecturer II in Structural Geology

Salary:–£8076–£12 945 (normally with further advancement to £15 045)

Applicants for this post must be experienced in the general area of structural geology and be willing to take responsibility for teaching at all levels in our degree course.

An interest in research is essential and experience of research supervision would be an advantage.

Application forms (to be returned by Friday 2 May, 1986) and further details may be obtained from the Personnel Officer, Plymouth Polytechinc, Drake Circus, Plymouth PL4 8AA. (Telephone: (0752) 264639.

Plymouth Polytechnic

Drake Circus, Plymouth
Devon PL4 8AA

Cell Biologist

The Lilly Research Centre is part of Eli Lilly and Company, a multi-national organisation firmly committed to the research, development and marketing of ethical pharmaceutical and agricultural products.

The Centre has a vacancy for a graduate or M.Sc with several years experience to join a research team working on the mechanisms underlying the chronicity of inflammatory diseases such as rheumatoid arthritis.

Ideally, the successful candidate will have experience in tissue and cell culture techniques related to cytokins activity in immune and non-immune systems. Experience of establishing T-cell lines would also be an advantage.

This appointment offers a highly competitive salary and benefits which include a non-contributory pension scheme, flexible working hours, 23 days annual holiday and an extremely attractive working environment.

Assistance with relocation expenses is given where appropriate.

If you would like to be considered, please contact:
Personnel Manager, Lilly Research Centre Ltd., Erl Wood Manor, Windlesham, Surrey GU20 6PH. Tel: Bagshot (0276) 73631

Lilly LILLY RESEARCH CENTRE

Heriot-Watt University Edinburgh

Postgraduate Study & Research In Intelligent Knowledge Based Systems/Man-Machine Interface

Applications are invited from graduates to undertake research in areas such as functional and logic programming, expert systems, inference, computer vision and graphics, logic data bases, man-machine interface and distributed computing.

It is expected SERC studentships will be available for suitable applicants.

Enquiries to: Postgraduate Co-ordinator, Department of Computer Science, 79 Grassmarket, Edinburgh EH1 2HJ.

WEST LAMBETH HEALTH AUTHORITY

St Thomas' Hospital London SE1

ITU TECHNICIAN

£6786-£8564 pa incl.

We need a qualified technician to join the technical support team in the Intensive Care Unit.

This challenging post is graded as a preventative maintenance, disinfection and repair of the ventilators used in the Unit, together with a range of patient monitoring equipment.

You will be expected to build up a close relationship with medical, nursing and other technician staff in the unit. Participation in an on-call rota will also be required.

Season ticket loan scheme is in operation, facilities include, swimming pool, squash courts and social club.

For further details please contact the Personnel Department, Tel 01-928 9292, Ext 3045.

An Equal Opportunities Employer.

ROYAL POSTGRADUATE MEDICAL SCHOOL
(University of London)

Department of
Paediatrics and Neonatal
Medicine

Applications are invited from graduates with experience in protein chemistry and/or recombinant DNA technology for a

RESEARCH ASSISTANTSHIP

to join a team working with Dr Mike Dunn on alterations in gene expression in Duchenne muscular dystrophy. The post is funded by the Ben Harwick Memorial Fund and is for one year in the first instance.

Salary on range £5566-£6905 plus £1133 London Allowance per year.

Application forms and further particulars may be obtained from the Personnel Office, Royal Postgraduate Medical School, 150 Ducane Road, London W12 0HS quoting Ref 28/ANW2.

Closing date 3 April, 1986.

ANALYTICAL CHEMIST
(Temporary Contract)

This is a temporary one year contract, to commence immediately, based in King's Lynn, Norfolk.

For the right person a competitive salary will be offered.

In the first instance please apply with a full cv and contactable telephone number to:
Glyn Jones, Personnel Manager

Dow Chemical Company Limited
Latchmore Court, Brand Street, Hitchin, Herts
SG5 1HZ.

Technical Manager

Drinks Industry **West Country**

Showerings Limited, a major Company within the Wines, Spirits and Soft Drinks Division of Allied Lyons PLC, successfully markets and sells such well-known brands as Babycham and Gaymers Olde English Cyder.

For our Headquarters at Shepton Mallet, Somerset, we now require an experienced Technical Manager, to apply a high level of scientific expertise to a wide range of technical activities. The intention is to ensure that the Company's high quality standards are met for existing products and the creative development of new ones.

The main activities of this well established and equipped function include current and new product development and process and packaging development/quality control.

Ideally we are looking for someone with a strong scientific background, in his/her 30's-40's, with a first degree in Microbiology or Biochemistry, ideally followed by postgraduate research leading to a higher degree.

To be considered you must have at least 8 years experience in the food/drink manufacturing industry, including at least 3 involving alcoholic products. You must also have several years management experience, along with the ability to effectively communicate with all levels and departments of the organisation and to motivate the Technical team.

Apart from excellent conditions of employment, including a company car, relocation assistance is provided, where appropriate to this beautiful part of Somerset.

Please write enclosing a detailed CV to:- The Recruitment & Training Officer, Showerings Limited, Kilver Street, Shepton Mallet, Somerset BA4 5ND. Tel: Shepton Mallet (0749) 3333 ext 2221.

Showerings

DEPARTMENT OF HEALTH AND SOCIAL SECURITY

British Pharmacopoeia
Commission, London

Chemist/Biochemist/ Pharmacist

The British Pharmacopoeia Commission is responsible for all standards published in Britain for substances and articles used in human and veterinary medicine.

You will work in the Commission's secretariat and assist in the development or revision of a group of monographs concerned with medicinal substances and pharmaceutical preparations. This will entail close involvement with certain committees and liaison with the Commission's laboratory at Canons Park and other relevant laboratories. You will also be responsible for certain aspects of liaison with the European Pharmacopoeia Commission.

You should have a first or second class honours degree or equivalent in pharmacy, biochemistry or chemistry or be a member of an appropriate professional body. At least two years' relevant post-graduate experience is required. The work requires familiarity with modern analytical techniques and a knowledge of the principles involved in the quality control of medicines. Familiarity with scientific editing would be an advantage.

Appointment as Higher Scientific Officer £9150-£11,905 (including £1365 Inner London Weighting) with starting salary according to qualifications and experience.

For further details and an application form (to be returned by 11 April 1986) write to Civil Service Commission, Alencon Link, Basingstoke, Hants RG21 1JB, or telephone Basingstoke (0256) 468551 (answering service operates outside office hours). **Please quote ref: SB/22/KD.**

The Civil Service is an equal opportunity employer

Scientific
CIVIL SERVICE

UNIVERSITY OF LONDON
CAREERS ADVISORY SERVICE

CAREERS ADVISER

Applications are invited from graduates in physical science or engineering for a post of careers adviser in the University of London Careers Advisory Service. The vacancy has arisen as a result of the appointment of a senior careers adviser as Head of Careers Service in another University and a subsequent internal promotion. Previous employment of at least four years, preferably outside the education field, is essential and experience or training in vocational guidance or personnel work would be an advantage although not an overriding requirement.

Salary will be in accordance with age and experience within Grade IA of the National Salary Structure for University Administrative Officers, currently £7055-£12 780 pa plus £1297 pa London Allowance, with membership of the University Superannuation Scheme. There will be the opportunity for promotion to the Grade II scale currently £12 280-£15 700.

Further particulars and application forms obtainable from the Personnel Office, University of London, Senate House, Malet House, London WC1E 7HU. Tel 01-636 8000, Ext 3259. Closing date for applications is 11 April, 1986.

MRC CLINICAL RESEARCH CENTRE
(Northwick Park Hospital)
Watford Road, Harrow
Middx. HA1 3UJ

crc

MOLECULAR BIOLOGIST

A non-clinical scientist is required in our Division of Rheumatology to join in an ongoing project to study the regulation of human acute-phase protein gene expression.

The long-term objective is to understand the pathogenesis of amyloidosis, a life threatening complication of chronic inflammatory diseases, experience of DNA sequencing and transfection is desirable.

This is a three year appointment in the first instance, and may be extended up to six years. Salary will be within the range £10 573-£16 819 inclusive depending on previous experience.

Informal enquiries may be made by contacting Dr P. Woo, 01-864 5311 Ext 2955/2675. Application forms and further information available from Betty Shaw, Personnel Section, quoting Ref 131/1/4124.

Closing date for completed applications, 10 April, 1986.

MORE VACANCIES ON PAGES 67—87

Laboratory Technicians

Coca-Cola Great Britain Limited is looking for experienced laboratory technicians to join the Company's highly sophisticated and technologically advanced quality assurance laboratory in Kensington.

Laboratory Technician

You will be involved in quality assurance on a day-to-day basis, operating computer systems to input product information and monitoring products, samples and packaging. You will also have general responsibility for maintaining the cleanliness of the laboratory and equipment.

You must have good 'O' and preferably 'A' levels with at least a year's lab experience in a food or chemical environment.

Senior Laboratory Technician

Besides your standard laboratory technician duties mentioned above, you will be responsible for handling all complaints regarding consumables. Bottlers and suppliers inventory and product/package compatibility testing are a few of your other duties.

You should be aged 25+ and qualified to degree level in chemistry, microbiology or food sciences, with at least 2 years' lab experience.

To fill either position, you must be both physically fit and have a methodical approach to your work.

Competitive salaries are backed by a range of attractive large-company benefits including pension, PPP and free travel within Greater London.

Please apply, giving career details and current salary, to Miss Deborah Khan, Employee Services Officer, Coca-Cola Great Britain Limited, Pemberton House, Wrights Lane, London W8 5SN. Tel: 01-938 2131.

Enjoy Coca-Cola

UNIVERSITY OF SURREY

DIRECTOR OF PROCESS BIOTECHNOLOGY

The University of Surrey is introducing a unique extended first-degree course in Process Biotechnology, leading to an MEng qualification. Applications are invited for the post of Director of this multi-disciplinary course.

The Director will be expected to undertake the development of the new MEng course, to co-ordinate and participate in research activities in Biotechnology, and to take the lead in industrial liaison and industrially-funded research in Biotechnology. The Director will be actively supported by the Departments of Chemical and Process Engineering, Microbiology and Biochemistry.

The appointment will be at the Reader/Senior Lecturer level. It is an opportunity for a relatively young person to become established rapidly as a leading member of the academic community in Process Biotechnology. A background in Chemical or Biochemical Engineering is essential. In this appointment, relevant industrial experience is at least as important as academic qualification.

Salary will be within the range £14 700-£18 415 pa (under review) according to qualifications and experience, with superannuation under USS conditions.

Further particulars are available from the Academic Registrar (AA), University of Surrey, Guildford, Surrey GU2 5XH, or Tel Guildford (0483) 571281, Ext 2031. Applications from men and women, in the form of a cv, including the names and addresses of three referees, should be sent to the same address by Friday, 25 April, 1986, quoting the reference 491/NS.

Assistant Hydrometric Officer

Salary £8 070—£9 024 pa

We have a vacancy in our office at Waltham Cross, Herts for an hydrologist to provide technical support to the team responsible for the operation of the hydrometric network in the eastern part of the Thames catchment.

The successful candidate will be involved in all aspects of river flow, rainfall and ground water data collection and processing, the analysis of hydrological data and the maintenance and development of data processing software. The person appointed will also participate in the operation of a fluvial flood warning service. The post would suit a young hydrologist keen to gain some practical experience in hydrometry.

Applicants should be graduates in an appropriate discipline with a sound knowledge of hydrology and preferably with a post graduate qualification in the subject. Some experience of computer programming particularly on microcomputers is essential.

Candidates should hold a current driving licence and be prepared to use their own cars for which an appropriate allowance willl be paid.

Application forms can be obtained from The General Manager, Personnel, 3rd Floor, King's Meadow House, c/o Nugent House, Vastern Road, Reading RG1 8DB. Telephone No Reading 593802. Closing date: 4 April, 1986.

Thames Water

RUNNING WATER FOR YOU

COVENTRY (LANCHESTER) POLYTECHNIC

Department of Production Engineering

RESEARCH ASSISTANT

(Two year appointment)

Plasma Welding Systems Research £6324-£7677

A Research Assistant is required to work in the area of Optimised Management and Control of the Automated Plasma Arc welding process.

This requires investigation into real-time control of the Robot Plasma-arc process using optimised parametric settings assessed from a generated data base and information accrued from sensory feedback.

A knowledge of electrical engineering and computing are considered essential. Candidates are preferred who have Electrical, Electronic or Applied Physics qualifications.

Further particulars and application form from Personnel Officer, Coventry (Lanchester) Polytechnic, Priory Street, Coventry CV1 5FB (Please enclose a large self-addressed envelope). Tel Coventry (0203) 24166, Ext 392. Closing date Thursday, 3 April, 1986.

An Equal Opportunity Employer.

UNIVERSITY OF CAMBRIDGE

MOLECULAR BIOLOGIST

A molecular Biologist is required to join a Cancer Research Campaign group currently involved in the isolation and characterisation of human DNA repair genes. The successful applicant would be expected to actively participate in this research as well as take responsibility for the running of the existing recombinant DNA laboratory.

Applicants should have a relevant first degree (or equivalent) and practical experience in microbiology/recombinant DNA technology. The post is available immediately and is funded in the first instance until December 1989. Salary will be at an appropriate point on the Cambridge University Assistant Staff R7 scale (£6935-£8334).

Applications, including a cv and the names of two professional referees, should be sent to Dr J. Arrand, Cancer Research Campaign Mammalian Cell DNA Repair Group, Department of Zoology, University of Cambridge, Downing Street, Cambridge CB2 3EJ, (Tel 0223-358717) from whom further information may be obtained.

COLEG PRIFYSGOL GOGLEDD CYMRU

UNIVERSITY COLLEGE OF NORTH WALES, BANGOR

POSTDOCTORAL RESEARCH OFFICER IN ORGANIC CHEMISTRY

Salary: £8020-£9495 pa

Applications are invited for the above post funded by the SERC for work on Reactivity and Synthetic Application of Eliminative Fission of Cyclic Compounds, under the direction of Professor C. J. M. Stirling.

The post will initially be available for one year from 1 October, 1986 but any starting date after 1 April, 1986 can be arranged.

Applications (two copies), giving details of qualifications and research experience, together with the names and addresses of two referees, should be sent to the Staffing Officer, Personnel Office, University College of North Wales, Bangor, Gwynedd LL57 2DG. (Informal enquiries may be made to Professor C. J. M. Stirling, Tel (0248) 351151, Ext 223.)

OPT FOR A SUPPORT ROLE IN ANALYTICAL INSTRUMENTATION

Hewlett-Packard has earned a worldwide reputation for advanced analytical technology through innovation, expertise and sound business sense. Have you the vision to join us and use your skills to build a challenging and well-rewarded career?

We need two professionals with the commitment to promote customer relations through a blend of technical ability and first-class communications skills.

Customer Engineers to £12k + Car Manchester and Borehamwood

These are excellent career moves for graduate or HNC qualified Chemists who wish to undertake problem solving roles in a fast moving environment with extensive customer contact. You will complement our existing customer support function by providing a comprehensive commissioning and maintenance facility for our extensive range of analytical equipment including gas and liquid chromatographs. You will troubleshoot on this sophisticated range of products, be involved in post sales activities, increase customer awareness, and sell services and courses.

You will have several years' experience in a progressive analytical laboratory environment or you may currently be servicing analytical instrumentation. A proven logical troubleshooting ability and plenty of initiative are essential. Experience of laboratory computation or a basic knowledge of electronics would be an asset.

Comprehensive training will be provided, both in the UK and abroad.

Starting salary depends on experience and is supported by an excellent benefits package that includes twice yearly profit-sharing and share-purchase, BUPA, pension and life assurance schemes.

To obtain your application form ring 061-428 8606 (24 hour response line). If you would like to discuss these positions in more detail please contact Debi Wilson-Brown, Personnel Department, Hewlett-Packard Ltd, Heathside Park Road, Cheadle Heath, Stockport, Cheshire SK3 0RB. Tel: 061-428 0828.

Hewlett-Packard is an equal opportunity employer.

We can work it out **HEWLETT PACKARD**

Instrumentation Officer

SW LONDON **up to £13,814**

A vacancy has arisen in the Instrument Services Group at Watson House Research Station in Fulham for an experienced Instrumentation Officer.

The Group is responsible for the design and the construction and commissioning of electronic, electromechanical and microprocessor based equipment for controlling and monitoring experiments in R&D laboratory and field studies.

Applicants should have a proven aptitude for this type of work, and previous experience of 8085 assembly language and BASIC programming is desirable.

Candidates should ideally possess an HNC/HND in Applied Physics or Electronics, although other qualifications with a suitable breadth of experience may also be considered. The appointment will be made in the salary range £7,523 to £11,692 or £13,814 [inclusive of Inner London Weighting] depending upon experience.

Write for an application form to Mr. H. Myles, Personnel Officer [Fulham] British Gas Corporation, Watson House, Peterborough Road, London SW6 3HN quoting reference number WH/456 or 'phone Mrs. White on 01-736 1212 ext 3358.

British Gas

an equal opportunities employer

Chemist

Night Shift

Travenol Laboratories – serving hospital and home medical care needs worldwide

Working in one of our laboratories you will be carrying out essential analytical chemistry work on a permanent night shift (10pm to 6am) from Sunday night to Thursday night inclusive.

This is an ideal first or second post for a career minded person educated to HNC or Degree level. Experience is preferred but not essential as full training will be given.

Rewards are competitive and include the usual large company benefits.

This is a newly-created post and previous applicants are welcome to re-apply.

To apply please 'phone Helen Norris (Personnel Department) for an application form.

TRAVENOL

Travenol Laboratories Ltd.,
Caxton Way, Thetford, Norfolk. IP24 3SE
Tel: Thetford (0842) 4581

MORE VACANCIES ON PAGES 67—87

Are you a Biologist?

THEN READ ON

ICI is expanding facilities at its Jealott's Hill Research Station as part of a major increase in its biotechnology research in the agricultural sector. As a result of this Exploratory Plant Sciences Department is in the exciting position of serving the needs of ICI Plant Protection Division's agrochemical business as well as providing the research base for ICI's newly formed International Seeds Business. We need a young scientist to meet this challenge. You will work in the glasshouses, growth rooms and laboratories on the development of chemicals for use as plant growth regulators. The successful applicant will have:

- a minimum of one 'A' level in a biological subject. An additional 'A' level in chemistry would be an advantage. A degree or equivalent in a biological or agricultural science is desirable;
- an interest in plant physiology and experience of working with plants in a research environment;
- enthusiasm, flexibility and ability to work at speed;
- good observation skills and a methodical and accurate approach to experimental work;
- numeracy skills. Some knowledge of computing and data handling would be an advantage;
- ability to communicate effectively both verbally and in writing, and to work well as part of a team;
- a clean, current driving licence would be desirable.

We give on the job training and an opportunity to further your education by day release. Prospects for promotion will be dependent on ability and performance.

Jealott's Hill Research Station is located in pleasant surroundings between Bracknell and Maidenhead. We offer good salaries and other benefits including membership of the Profit Sharing Scheme and Pension Fund. There is a staff restaurant, recreation club and shop on site.

Candidates should apply to the address below, giving a cv covering details of their education to date with any relevant experience. They should also indicate why they are particularly interested in this job and any other special skills which might suit them to this position. The closing date for this vacancy is 4 April, 1988.

Personnel Department, ICI Plant Protection Division, Jealott's Hill Research Station, Bracknell, Berkshire RG12 6EY.

Please quote reference number EPSG/EA.

ICI Plant Protection Division

Polymer Scientist

A career role in an atmosphere of diversification and expansion

As one of Britain's major chemical companies—and exporters—we have remained amongst the leaders for over half a century, through our commitment to expansion, allied to development of a broad product base.

Based in our R & D Department at Ellesmere Port on the Wirral, you'll join a small team developing our knowledge of materials behaviour in a widening range of process conditions, advising the management on the use of construction materials and supervising on-site applications of those materials.

Having developed a background knowledge of resin, plastic and rubber behaviour in our process streams, you'll carry out analyses of process plant failures, preparing specifications and giving advice to ensure effective protection of process plant for use in highly corrosive conditions. In addition, you'll develop methods of testing plastic linings and will be responsible for technical supervision during on-site fabrication.

Preferably aged under 30 years, you must have a good honours degree in Polymer or Materials Science and preferably 2 years' relevant post-graduate experience, either at University or within industry. Some knowledge of corrosion science would be an advantage.

We offer a competitive salary, and conditions of employment include a Contributory Pension Scheme and BUPA membership.

Please write, enclosing a comprehensive cv, or telephone for an application form to:- Staff Recruitment Officer, The Associated Octel Company Limited, PO Box 17, Ellesmere Port, South Wirral L65 4HF. Tel: 051-355 3611 ext 148.

AGRICULTURAL AND FOOD RESEARCH COUNCIL

Institute of Food Research—Norwich Laboratory

POSTDOCTORAL POSITIONS BIOCHEMIST/CHEMIST

As a result of the Council's new initiative on Cell Signalling and Recognition, two postdoctoral fellowships are available, each tenable for three years, to join an established group with substantial experience in the structural determination of cell-wall biopolymers. The aim is to exploit the expertise to begin an area of research into the isolation and characterisation of physiologically active oligosaccharides from cell-walls. The positions are suitable for young scientists with a background in either biochemistry or organic chemistry who are keen to explore a new area.

Post No. 86/NI/1: A biochemist is required to carry out investigations into the chemical or enzymic degradation and release of biologically active oligosaccharides. Studies in physiological activity will also be involved and will be carried out in collaboration with colleagues at the John Innes Institute.

Qualifications: A first or upper second class honours degree and a PhD in biochemistry. Experience with enzyme purifications or with studies in growth regulators in plants will be desirable.

Post No. 86/NI/2: A chemist is required to characterise the oligosaccharides using modern chromatographic and spectroscopic techniques including GC-MS, FAB-MS and high resolution NMR methods. Some structural modifications and synthesis will also be involved.

Qualifications: A first or upper second class honours degree in chemistry and a PhD in organic chemistry. Experience in structural characterisations using mass spectrometry and NMR spectroscopy is essential.

Appointment will be made at the Higher Scientific Officer level and will be for a maximum of three years.

Salary scale: £7788-£10 541 pa. Non-contributory superannuation scheme.

Further details and application form from the Secretary, Mr V. H. Standley, Institute of Food Research, Norwich Laboratory, Coiney Lane, Norwich NR4 7UA, quoting the appropriate reference.

Closing date: 3 April, 1986

ROYAL COLLEGE OF SURGEONS OF ENGLAND

Dental Research Unit—Downe

GRADUATE RESEARCH ASSISTANT

to join a team investigating the molecular basis of pathogenicity of bacteria involved in dental caries, with emphasis on components of potential value in a caries vaccine. A wide range of biochemical, bacteriological, immunological and genetic engineering techniques in use in the laboratory. Experience in one or more of these is therefore desirable.

The position is available immediately and the initial contract will be to June 1987. Salary on the Universities Research and Analogous scale, according to age and experience.

Applications giving full cv and names and addresses of two referees to: Assistant Secretary (Personnel), Royal College of Surgeons of England, 35-43 Lincoln's Inn Fields, London WC1A 3PN.

Please quote Ref 17/86.

Closing date: 10 April, 1986.

THE QUEEN'S COLLEGE GLASGOW

1 Park Drive. Glasgow. G3 6LP. Tel: 041-334 8141.

DEPARTMENT OF APPLIED AND LIFE SCIENCES

LECTURER 'A' IN BIOCHEMISTRY & PHYSIOLOGY

Salary scale £9321-£14 718

Applications are invited from graduates who can teach the subjects to Degree and Diploma students mainly in the paramedical areas, including Dietetics, Orthoptics and Physiotherapy.

LECTURER 'A' IN FOOD SCIENCE

Salary scale £9321-£14 718

The person appointed will be a graduate who will teach applications of Food Science for Degree and Diploma students in Dietetics, Home Economics and Catering. A special interest in Food Analysis or Organic Chemistry would be valuable.

Further particulars and application forms for both posts are available from the Secretary & Treasurer at the address above. The closing date for receipt of applications is 4 April, 1986.

A Scottish Central Institution.

CLINICAL TRIALS OFFICER

Due to an expanding research and development programme, Lundbeck Limited has further vacancies for Clinical Trials Officers to undertake pre- and post-marketing clinical trials in the UK and Ireland.

Applicants should be qualified in pharmacy, pharmacology, biochemistry or biology. The essential requirement is experience in the design, planning, arrangements and follow-up of clinical trials, both in the GP and hospital setting. Preference will be given to applicants with experience of clinical trials, particularly in psychopharmacology.

It is envisaged that suitable candidates will be 25-35, enthusiastic, with a sound professional outlook. The salary offered is negotiable depending on experience, and a Company car will be provided. The positions will be based at our offices in Luton.

Additional benefits include free BUPA, life, personal accident and permanent health insurance; a first-class pension scheme and four weeks annual holiday (rising on service).

Applicants should in the first instance send a full CV and salary history to:

Mrs Rita Winters
Lundbeck Limited
Lundbeck House
Hastings Street
Luton, Beds LU1 5BE

BIOSCOT LTD

is a rapidly expanding biotechnology company engaged in the development and production on monoclonal antibody based diagnostic reagents and kits with applications in medicine, veterinary science and agriculture.

With the move to a new purpose built headquarters and laboratory complex, several vacancies exist for scientific and technical/production staff with experience in Hybridoma technology, particularly:

- HYBRIDOMA ISOLATION
- LARGE SCALE CELL CULTURE TECHNIQUES
- ASSAY DEVELOPMENT
- IMMUNOAFFINITY CHROMATOGRAPHY

This an excellent career opportunity to join a team dedicated to the commercial development of monoclonal antibodies with a competitive salary commensurate with experience.

For consideration please send in confidence a cv, the names of two referees and an indication of current salary level to **Mrs F. M. Craig, Adminstrative Coordinator, Bioscot Ltd. Kings Buildings, West Mains Road, Edinburgh EH9 3JF.**

UNIVERSITY OF ABERDEEN

LECTURER IN EXPERIMENTAL PHYSICS

Applications are invited from suitably qualified persons (PhD or equivalent) for the post of lecturer in the Department of Physics. The appointment will be for five years from 1 October, 1986 and the successful candidate will be expected to take a leading role in research as well as contributing to the teaching on the four year undergraduate programme.

The Department has recently established new research facilities in the study of multiphoton laser ionisation of molecules and in the development of thin multilayer mirror systems for soft x-ray optics. These areas are supported by well equipped workshops and metrology laboratories and it is expected that the successful applicant will have experience in these or related research areas.

Salary on the Lecturer Scale £8020- £15 700 per annum.

Informal enquiries may be made to Professor G. V. Marr, Head of Department (Tel 0224 40241 Ext 5488).

Further particulars and application forms from The Secretary, The University, Regent Walk, Aberdeen AB9 1FX, with whom applications (two copies) should be lodged by 1 May, 1986. Ref ED/024.

THE CIBA FOUNDATION

RESEARCH ASSISTANT

(temporary/part time)

The Ciba Foundation is an international, scientific and educational charity providing a range of services to science and scientists. The Foundation is seeking a Research Assistant for a project to evaluate the effectiveness of current methods for training research workers in biomedical science. The work will involve the collection of bibliometric data, the analysis of publication citations and some computer work.

Applicants should preferably be science graduates with an interest in information science.

The appointment is for six months at 20 hours per week (times open to discussion).

Salary at rate of £7500 – £8500 pa pro rata.

Application by letter, with cv, should be sent to: **Dr J. Anderson, The Ciba Foundation, 41 Portland Place, London W1N 4BN.**

Closing date: 11 April, 1986.

COURSES MANAGER

WIMBLEDON

CIRCA £18 000

CHAM is a UK-based Software House/Consultancy specialising in fluid flow stimulation.

Our Client Education Programme has grown to become central to our activities.

This is a new and unusual appointment carrying responsibility for the management and further development of this programme. It offers a new career direction to either:

- an experienced lecturer-teacher–or
- an enthusiastic engineer-scientist keen to move into a senior commercial role

Benefits include BUPA, a non-contributory pension scheme and a young, dynamic working environment.

Applications will full cv to: Alana Imrie, CHAM Limited, Bakery House, 40 High Street, Wimbledon SW19 5AU

NATURE CONSERVANCY COUNCIL

Applications are invited for the contract post of Field Studies Officer which is based at the Dyfi National Nature Reserve, Nr Aberystwyth. The successful applicant will assist with the development of a variety of facilities for field studies.

Salary
£6190–£8561 dependent on age and qualifications.

Duration of Contract
Initially from 14 April, 1986 until 30 September, 1986, with the possibility of an extension beyond that date subject to a maximum of five years.

Age and Qualifications
Candidates should possess a first or second class honours degree, preferably with at least two years relevant post graduate experience. A proven interest in field studies and a current driving licence are essential.

Application forms and further details can be obtained from Mr A. B. Pritchard, Nature Conservancy Council, Dyfed-Powys Region, Plas Gogerddan, Aberystwyth, Dyfed SY23 3EE.

Closing date for receipt of application forms is 2 April, 1986.

MORE VACANCIES ON PAGES 67–87

LAPORTE

Process Development Chemist

Owing to business expansion we have immediate vacancies in our Group Research & Development Department, based on the outskirts of Widnes, for chemists with a good honours degree (first or upper second class) and with at least two years experience in the development of processes for manufacturing chemical intermediates.

The posts will involve the investigation of new and existing processes at the laboratory, pilot plant and small scale production levels. A commitment to practical organic chemistry is sought, ideally with evidence of previous innovations in the field of process development.

Career prospects within the Group are considered to be excellent and the remuneration package, which includes a non-contributory pension scheme and relocation assistance where necessary will be competitive.

Applications should give full details of education, qualifications, experience and achievements to date and be sent to Mr. J. R. Crampton, Deputy Head of Group R&D, Laporte Industries Limited, Moorfield Road, Widnes, Cheshire, WA8 0JU.

LAPORTE

BRIGHTON POLYTECHNIC

DEPARTMENT OF PHARMACY

RESEARCH POSTS

Applications are invited from graduates in biology, chemistry, pharmacy, physics and related disciplines for a postdoctoral fellowship and two research assistantships. The project will be directed towards the synthesis of a novel series of compounds to protect both mammalian cells and liposomes against the damaging effects of freezing at temperatures down to those of liquid nitrogen. It is also proposed to study mechanisms of action using both biological and physical methods of assessment and to include the development of appropriate instrumentation and techniques.

Appointments will be made for two years in the first instance, with possible renewal for a further year. The successful applicants will be required to start as soon as possible, although consideration will be given to candidates expecting to graduate this Summer with a view to a September start.

Research assistants will be expected to register for a higher degree.

Salary:

Research Assistant £5541-£6324

Research Fellow £8076-£10 968

Further details and application forms available from the Personnel Department, Brighton Polytechnic, Mithras House, Lewes Road, Brighton BN2 4AT. Tel (0273) 693655 Ext 2537.

Closing date: 17 April, 1966.

Information Specialist

£11,580 to £14,053 p.a. inc.

The Electricity Council is the central co-ordinating body for the electricity supply industry in England and Wales.

The post is primarily concerned with the production of digest material for dissemination within the electricity supply industry, literature research and briefing, particularly in the fields of energy statistics, economics and finance.

You may already have worked in the field of information science and/or hold a relevant post graduate qualification. Possession of a good economics and/or science degree, and a proven flair for writing with an ability to present complex information succinctly are essential.

Please write giving details of age, qualifications, experience and present salary, quoting ref: 3/NS to:
David Webb, Recruitment Officer,
The Electricity Council,
30 Millbank, London SW1P 4RD.

The Council has Equal Opportunity Policy and welcomes applications from disabled people.

ELECTRICITY COUNCIL

ROYAL POSTGRADUATE MEDICAL SCHOOL
(University of London)
Department of Clinical Pharmacology

RESEARCH OFFICER

A vacancy exists in the Department for a graduate biochemist to work on the biosynthesis of leukotriene C4 and related aspects of eicosanoid biochemistry

Some experience with either HPLC, enzyme purification or cell culture would be an advantage, although training will be given where necessary.

The position is supported by the Medical Research Council until September 1987. The starting salary will be £6600 plus £1297 London Allowance a year (Range 1B).

Application forms and further particulars may be obtained from the Personnel Office, Royal Postgraduate Medical School, 150 Ducane Road, London W12 0HS quoting ref: 20/202/NS.

Closing date 3 April, 1986.

THE INSTITUTE OF CANCER RESEARCH

A RESEARCH TECHNICIAN or JUNIOR TECHNICIAN

is immediately required to work on oncogenes in Dr C. J. Marshall's laboratory. Applicants should have an interest in both cell and molecular biology with either a degree or technical qualification for Research Technician or science A levels for Junior Technician. If a Junior Technician is appointed it would be expected that they attend day release for a higher qualification.

Salary in the range £4108-£8477 pa, plus London Allowance of £1084 pa.

Applicants are advised that in the majority of the Institute's premises smoking is prohibited.

Applications, in duplicate, with the names and addresses of two referees, to the Personnel Officer, The Institute of Cancer Research, 17A Onslow Gardens, London SW7 3AL, quoting reference 2/86/T/NSC/7.

THE UNIVERSITY OF LIVERPOOL

Department of Biochemistry

TECHNICIAN GRADE 3

Required to assist in a research group directed by Prof B. E. H. Maden.

Candidates must possess ONC or appropriate equivalent as a minimum qualification plus three years experience preferably in biochemistry or molecular biology. Experience in handling Xenopus oocytes would be a particular advantage.

This post is available immediately for a period of eight months and will be renewable if further funding becomes available.

Salary pro-rata £5683 pa.

Applicaton forms may be obtained from The Registrar (NAS), The University, PO Box 147, Liverpool L69 3BX. Ref: PER/942.

INFORMATION OFFICER
c. £9500

to run the library/information service at the **Chemical Industries Association.**

The Information Officer, supported by an assistant, provides an information service to member companies, to Association staff and to outside enquirers.

Applicants should have training and/or experience in information science together with a qualification in chemistry or a related subject.

Starting salary will be around £9500 and is supported by a benefits package including luncheon vouchers, pension scheme and season ticket loan.

Application forms from: Valerie Flindall, CIA Ltd, Alembic House, 93 Albert Embankment, London SE1 7TU; Tel: 01-735 3001.

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QUEEN MARY COLLEGE
(University of London)

DEPARTMENT OF MATERIALS

LECTURER IN MATERIALS

Following the departure of Dr R. J. Young to take up the Chair and Headship of Polymer Science and Technology at UMIST, applications are invited for a Lectureship in Materials. Applicants should have a PhD and some relevant post-doctoral experience in Materials Science or a related discipline. The Department has an active and comprehensive research programme including structural, mechanical and electrical studies of biomaterials, polymers, composites, ceramics and metals. The new Lecturer would be expected to make a significant research contribution either within the context of the existing programme or by the development of semiconductor related-research.

Salary in the lower half of the scale £8020-£15 700, plus £1297 London Allowance. Application forms and further details are available from the Assistant Personnel Officer, Queen Mary College, Mile End Road, London E1 4NS. Please quote reference 86/27/NS. Closing date 22 April, 1986.

UNIVERSITY OF READING

LECTURER IN ENZYMOLOGY: DEPARTMENT OF FOOD TECHNOLOGY

Applications are invited for a five year fixed term lectureship in enzymology in the Department of Food Technology. The successful candidate will join an active and expanding research group in biotechnology, whose current interests include bioreactor design, microbial and fungal processes, solid substrate fermentations and enzyme production. The purpose of this post is to strengthen research in applications-oriented areas of enzymology, and to develop undergraduate and postgraduate teaching in these and related areas. Ideally, the candidate will have strong qualifications in biochemistry and/or enzymology and relevant research experience. Salary scale £8020-£15 700 pa plus USS/USDPS benefits. Informal enquiries will be very welcome and should be addressed to Prof D. L. Pyle, Department of Food Technology, University of Reading, Food Studies Building, Whiteknights, PO Box 226, Reading RG6 2AP. Further particulars and application forms (two copies) are available from the Personnel Officer, University of Reading, Whiteknights, PO Box 217, Reading RG6 2AH, Tel (0734) 875123, Ext 220. Please quote Ref AC865. Closing date 11 April, 1986.

UNIVERSITY OF HULL
Department of Biochemistry
POSTDOCTORAL RESEARCH ASSISTANT

Applications are invited for the above post, funded under the ICI Joint Research Scheme, to work on the production of novel polymers by micro-organisms. Applicants preferably should have experience in microbial biochemistry and enzymology and familiarity with chemostat operation would be an advantage.

The post is tenable for three years on the IA scale (initial salary up to £8379). Further details are available from Professor E. A. Dawes to whom applications including full cv and the names of two referees, should be made by 18 April, 1986.

SICPA
SICPA SA LAUSANNE

SICPA is a large Swiss based multinational company and a leader in the field of general and speciality inks and related products. It has large modern laboratories and manufacturing plant in Lausanne where the successful applicant will be based.

To join our highly qualified team we seek a

SURFACE COATING SCIENTIST

who will carry out work in areas of new resin and polymer synthesis and the evaluation of these in specialist and general ink applications.

The applicant should preferably be 25-35, a graduate or postgraduate in chemistry or disciplines related to organic polymer chemistry/physical chemistry.

Experience in the synthesis and development of inks, coatings and their commercial applications will be a great advantage.

The terms and conditions will be those expected from a leading company in Switzerland and all removal and relocation expenses etc. will be met.

For further details and an application form apply in confidence with a full cv to:

Mr M. Magnenat
Personnal Manager
SICPA S.A. (Ref.1)
CH 1000 LAUSANNE 16
Switzerland

Applicants initially selected will be invited to SICPA with expenses paid.

Quality Control Laboratory Technician

£10,744 p.a. **S.W. London**

If you are a graduate or qualified to HNC/HND level in chemistry, physics or other relevant scientific subjects and have some experience in the brewing or allied industry you could be just the person we are looking for.

The position that we have requires knowledge of routine and non-routine brewing analyses, G.C. analysis, looking after complex equipment and working with a computer for data entry and retrieval. Some shift work will be required.

The successful candidate, preferably aged between 25 and 34, must be able to work within a group of technicians providing analytical and microbiological process control data to the production function.

We offer rapid progress through the salary band, and the sort of benefit package associated with a large and progressive company.

If you think this is the kind of job you qualify for telephone G. Day, on 01-876 3434 for an application form or write to: Personnel Department, Watney Combe Reid & Truman Ltd., Stag Brewery, Mortlake, London SW14 7ET.

WATNEY COMBE REID
1898

MEDICAL EDITORS

We are expanding, with more work in the pipeline than our present very experienced editorial team can handle.

We are looking for medical editors, preferably science graduates with experience, to take charge of editorial projects from beginning to end. Our publications are usually based on scientific meetings which we organise and run, and your work would begin with preparing abstracts beforehand, ending with supervision of proceedings publication. You might also be called on to write and obtain speaker approval for 'highlight' magazines based on the meetings, to coach speakers in the use of computer interactive systems during their presentations, to supervise slide production – or prepare posters for display during the meeting.

Most of our clients are in the pharmaceutical industry and, as we are part of a major international group, we offer opportunities for travel.

Our offices are shortly moving to Worthing, where you would be based. We offer free BUPA and life assurance, plus long-term sickness insurance, and a first class pension scheme.

Write to Nick Landon, Editorial Director, Professional Postgraduate Services Limited, Sunderland House, Sunderland Street, Macclesfield, Cheshire SK11 6JF, and say why you are suitable for one of these posts. Also give an idea of the salary you would require.

INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE

ASSISTANT ZOOLOGIST– 3 YEAR APPOINTMENT

Applications are invited for the post of Assistant Zoologist to join three other members of the Secretariat of the International Commission on Zoological Nomenclature. The post is tenable for three years. It is based at the British Museum (Natural History), although the person appointed will be employed by the International Trust for Zoological Nomenclature.

Applicants should have (or be taking in 1986) a degree in zoology and be familiar with taxonomic practice. The job requires the ability to express complex information clearly and to undertake detailed bibliographic searches in the BM (NH) libraries.

The starting salary will be £6951 (under review), including London weighting and payment in lieu of superannuation. An additional allowance may be paid for exceptional experience.

Further details and an application form can be obtained from the Scientific Administrator, ICZN, c/o British Museum (Natural History), Cromwell Road, London SW7 5BD. Application forms should be returned by 1 May, 1986.

UNIVERSITY OF MANCHESTER

POSTDOCTORAL RESEARCH ASSOCIATE IN BIOCHEMISTRY

Applications are invited for this post, tenable for up to three years, from candidates with a special interest in the biochemistry of the fibrinolytic system and microvascular disorders. Salary in the range of £7520-£12 150 pa (under review) according to qualifications and experience. Superannuation.

Applications including the names of three referees, should be sent to Prof M. I. V. Jayson, Rheumatic Diseases Centre, Hope Hospital, Salford M6 8HD, as soon as possible.

MORE VACANCIES ON PAGES 67–87

OPPORTUNITIES IN MEDICAL DIAGNOSTICS

With The Boots Company PLC and Celltech Limited as our joint shareholders, we have achieved remarkable expansion since our formation in 1983. Our discipline is medical diagnostics where we are researching, developing and manufacturing a range of biotechnology-based products. We anticipate the world's diagnostic market, in which we are a major innovator, will top £1,000 million by 1990.

We are now looking to fill the following posts within our Research and Development Division.

IMMUNOASSAY SCIENTIST

A vacancy exists for a graduate or similarly qualified person. The successful candidate should have had at least 2 years' experience in the area of enzyme immunoassay and is required to join a team engaged in the research and development of novel monoclonal antibody based systems. Initially, the work will relate to assays for assessment of fertility status. (Ref: EW)

TECHNICAL SCIENTISTS

Opportunities now exist for two enthusiastic technical scientists in our clinical chemistry and scientific services departments. Applicants should be qualified to HND or equivalent level.

These positions involve laboratory-based product support activities and therefore demand versatility, independence and attention to detail. Practical experience in biochemical, microbiological or immunological techniques is essential. Candidates should also possess organisational skills and the ability to analyse and document data accurately. (Ref: SGD)

We offer competitive salaries, 23 days paid leave, contributory pension/life assurance scheme and relocation where appropriate.

Please apply in writing stating Ref. Code with full career and salary details to:
Denise Tullett, Personnel Manager,
BOOTS-CELLTECH DIAGNOSTICS LIMITED
240 Bath Road, Slough, Berkshire SL1 4ET

THE UNIVERSITY OF MANCHESTER
Department of Basic Dental Sciences

TECHNICIAN IN CELL BIOLOGY

Applications are invited for this University established post. The successful applicant will carry out techniques in, and have major responsibilities for, general cell biological research investigations, immunocytochemistry, electron microscopy and monoclonal antibody production. There is a lively research environment centring on cell-matrix interactions in development and disease: the successful applicant will initially work closely with one of the permanent staff members. The lab of this new department has recently been refurbished and equipped and this post presents an opportunity to become closely involved with an exciting cell/developmental biology research programme. Salary scale £5683 to £6657 pa (under review). Send full cv plus names and addresses of two referees, by 4 April, 1986 to: Professor W. M. J. Ferguson, Department of Basic Dental Sciences, University of Manchester, Dental School, Higher Cambridge Street, Manchester M15 6FH from whom further details can be obtained.

Department of Medicine

RESEARCH TECHNICIAN

required to work on a project concerned with the metabolic and hormonal effects of diphosphonates in malignant disease. The appointee will work under the direction of Dr E. B. Mawer in the University Medical School and will be involved principally in the assay of vitamin D metabolites. Applicants should have ONC, HNC or a degree in an appropriate subject; experience of RIA would be an advantage. The post is for one year in the first instance with the possibility of renewal for a further two years. Salary scale £5844 to £6657 (under review) according to age and experience. Applications with full details to Dr E. B. Mawer, Dept. Medicine, University of Manchester Medical School, Oxford Road, Manchester M13 9PT.

NCH EUROPE INC
EUROPEAN TECHNICAL SUPPORT CHEMIST

An international leader in the field of industrial maintenance products requires an experienced, innovative Technical Support Chemist to join a small dynamic team at its European laboratory. The company places high emphasis on the quality of its customer and sales support activities. Preference will be given to candidates with experience in one or more of the following areas: petroleum, oil field supply, corrosion inhibition, lubrication, metal cleaning and surface coating.

Applicants should be chartered chemists or equivalent with several years' industrial experience and will have remonstrated his/her ability to communicate and manage a diverse information flow. Foreign language and/or computer language ability would be a plus.

The position attracts all the usual benefits associated with an international company.

Apply in writing, giving details of qualifications and experience to: **Mrs Sue Clarke, Secretary to Chief Chemist—Operations Europe, NCH Europe INC, High Holborn Road, Codnor Gate Industrial Estate, Derby DE5 3NW.**

QUEEN MARY COLLEGE
(University of London)

School of Mathematical Sciences
Research Positions in Dynamics

Applications are invited for postdoctoral research assistantships in the Queen Mary College Dynamics research group of the School of Mathematical Sciences. Enquiries concerning the visitors' programme are also very welcome.

Several important topics of dynamics research were initiated at QMC, where the main area of study is regular and chaotic motion in Hamiltonian systems, together with its applications. This forms a central theme for a wide range of active research areas.

The research group consists of eight permanent members of staff (Prof I. C. Percival, Drs D. K. Arrowsmith, S. R. Bullett, P. McCarthy, R. K. Tavakol, A. Tworkowski, F. Vivaldi and F. J. Wright), together with research assistants and research students. There are also stimulating links with the solar system dynamics studies of Drs C. Murray and I. P. Williams of the Astronomy Research Unit.

Postdoctoral applications should include (1) a brief cv and publications list, (2) a description of the candidate's recent work,(3) future research intentions, (4) names and addresses of two referees. The positions are normally for two years. Salary in the range £8020-£10 375 plus London Allowance of £1297 but one post may be at a more senior level. Applications should be sent to arrive not later than 15 April 1986 to Assistant Personnel Officer, Queen Mary College, Mile End Road, London E1 4NS.

Please quote reference 86/28/NS.

ESSEX NATURALISTS' TRUST

NATURE RESERVE WARDEN

The Trust requires a Full-time Reserve Warden for the new Roding Valley Meadows Local Nature Reserve, Loughton. Duties include habitat management, interpretation and recording of flora and fauna. Successful applicant will have experience in nature conservation/countryside management and probably a relevant degree. **Salary £7000.**

ASSISTANT CONSERVATION OFFICER

A one-year post based at Trust headquarters–duties include preparation of management plans, processing of site records and nature conservation advisory work. Successful applicant will have a relevant degree, be enthusiastic and adaptable and preferably have some knowledge of the voluntary nature conservation field. **Salary £6190.**

Closing date for applications 9 April.

Job descriptions from ENT, Fingringhoe Wick, Fingringhoe, Colchester, Essex CO5 7ND.

These posts are grant aided by the Nature Conservancy Council.

ANIMAL AND GRASSLAND RESEARCH INSTITUTE

TEMPORARY SOIL SCIENTIST

required in the Permanent Grassland Department, North Wyke, Okehampton, Devon to join a team working on the effects of seasonal pattern of fertiliser application on animal production and nitrogen transformations in grazed grassland. The appointee will be responsible for measuring nitrogen transformations, particularly in relation to loss through leaching. The appointment is for one year with the possibility of extension.

Qualifications: Degree or equivalent in Soil Science, Agricultural Science or a related subject. Preference will be given to applicants with some research experience.

Starting Salary: Scientific Officer £6190-£6878 according to qualifications and experience.

Application forms from the Personnel Officer, Animal and Grassland Research Institute, Hurley, Maidenhead, Berks SL6 5LR to be returned by 9 April, 1986 quoting 4/J/49.

UNIVERSITY OF BATH
School of Biological Sciences

LECTURER IN INSECT SCIENCE

Applications are invited from scientists with expertise in basic or applied insect physiology/biochemistry to complement and further develop the already considerable research activity in insect science.

Salary £8020–£15 700 pa.

Further particulars and application forms from the Personnel Officer, University of Bath, Bath BA2 7AY, quoting reference 86/49.

Closing date for applications: 24 April, 1986.

PRODUCTION MANAGER PHARMACEUTICALS

We are a substantial independant manufacturer of solid dose form medicinal products, located in West London. We require a chemist or pharmacist as Production Manager, answerable directly to the Managing Director for all aspects of production, other than QA. Applicants *must* be 'Qualified Persons' within the terms of the EEC directive, but all other criteria are open to discussion. We offer a good salary (£16K+) plus car etc.

Applications should be addressed to: The Managing Director, Box D914.

ACQUISITION EDITOR

We are looking for an Acquisition Editor to manage and develop an existing list of books and journals at postgraduate level.

The ideal candidate will be a science or engineering graduate with proven experience in commissioning STM material. However, we are willing to consider candidates with other relevant backgrounds in science or publishing.

The position offers considerable editorial scope as well as the opportunities that come from working within a major international publishing group.

The Acquisition Editor will be based at our Barking offices. He or she will be expected to travel extensively, mainly in the UK but also overseas. A competitive salary and other benefits will be provided, as will a company car.

Please write with full details to: Robert Lomax, Elsevier Applied Science Publishers Ltd., Crown House, Linton Road, Barking, Essex IG11 8JU.

The closing date for applications is 7 April, 1986.

Elsevier Applied Science Publishers Ltd

THE WEST OF SCOTLAND AGRICULTURAL COLLEGE

An Equal Opportunities Employer

LIBRARIAN

Applications for the above post are invited from qualified librarians with previous experience in a scientific or educational library.

The College has students studying for qualifications ranging from diploma to postgraduate level, and staff who are involved in research and development in all areas of agricultural production and marketing, along with a field advisory service.

Salary will be on the Higher Executive Officer Scale:
£8896 rising to £11 265 per annum.

Application forms and further particulars are available from the Personnel Officer, The West of Scotland Agricultural College, Auchincruive, Ayr KA6 5HW, with whom applications should be lodged not later than Friday, 4 April, 1986.

SATRA FOOTWEAR TECHNOLOGY CENTRE

YOUNG PHYSICIST

SATRA Footwear Technology Centre is a progressive industrial research organisation with worldwide membership. Situated in Kettering, a market town in Northamptonshire, SATRA provides research and services for its 1000 member firms. It is involved in all facets of the footwear industry from material and component testing to robotics and management control systems.

We are looking for a practical graduate with a physics background to undertake experimental research into the performance of shoe components and complete footwear.

Initially, he/she will be involved in syudying the stresses imposed on leather and synthetic shoe upper materials during shoemaking in the factory and going on to study the strains imposed in wear. The work will involve the use of transducers and video techniques, leading to test development with computer control.

The position will suit a recent graduate with a physics, materials or engineering orientated degree. An interest in computer applications would be an advantage but is not essential. Starting salary in the range £6000-£7000 depending on qualifications. Advantages include flexible working hours, non-contributory pension scheme, subsidised canteen facilities and an active sports and social club.

Applications in writing to:

Mr C. W. J. Foot
Head of Administration Department
SATRA Footwear Technology Centre
SATRA House
Rockingham Road
Kettering
Northants NN16 9JH

FMBRA

FLOUR MILLING AND BAKING RESEARCH ASSOCIATION

RESEARCH SCIENTIST

We have a vacancy for a graduate with a BSc or PhD to carry out research on scientific projects related to wheat and milling. Training will be given in technical aspects of flour milling. Since the work also involves some participation in assessing the milling quality of home-grown wheat varieties, liaison with member mills and installing and monitoring prototype equipment.

The initial salary will be related to age, qualifications and any previous job experience, with good prospects of promotion for a suitable candidate. Please send your cv to: Martin Yates, FMBRA, Chorleywood, Herts WD3 5SH.

Closing date for applications is 25 April, 1986.

UNIVERSITY OF BRISTOL

Long Ashton Research Station

POSTDOCTORAL PLANT PHYSIOLOGIST/BIOCHEMIST

Two Year Appointment

Applications are invited for a new post to study at the cellular level, the mechanisms of action of light and other environmental factors involved in determining dormancy status of weed seeds.

The successful candidate will join scientists in the Weed Research Division who are investigating ecological, physiological and biochemical aspects of weed seed germination.

Applicants should be postdoctoral plant physiologists/biochemists experienced in cell fractionation, immunological and gel electrophoretic techniques.

The appointment, which is pensionable, will be in the Higher Scientific Officer grade (£7788-£10 541 pa).

Further particulars and application form from the Secretary, Long Ashton Research Station, Long Ashton, Bristol BS18 9AF. Closing date for receipt of applications forms: 2 April, 1986.

Systems Engineering Mathematical Modelling

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MORE VACANCIES ON PAGES 67—87

Dark star

COMETS ARE renowned for bringing doom and despair. But the spectacularly successful results from Giotto (and the other Halley's Comet probes) have proved quite the reverse. They also argue well for a long-lasting spirit of international scientific cooperation. The scientists are understandably jubilant—even if the public may be disappointed that the brilliantly coloured images that flashed so incomprehensibly across our television screens last week have turned out not to represent the promised gleaming snowball, but only gas coming from a body so dark, dirty and unglamorous that even Giotto's camera ended up ignoring it. Still, it's not often we get a science spectacular that keeps a television audience estimated at 1300 million, in 36 countries, awake until a time that (in Britain at least) is when only astronomers are usually functioning.

The ultimate success of Giotto goes beyond whatever we have learnt about Halley's Comet. It has been an outstanding example of international collaboration. Eleven countries got together and designed not a camel, but a thoroughbred racehorse. With NASA currently in agonies and put in the shade by its own lack of a Halley probe, Giotto's success gives the European Space Agency (ESA) a deserved international stature.

More important even than the cooperation within ESA—which we have also seen in organisations such as CERN—is the cooperation between ESA and the space agencies of the United States, the Soviet Union and Japan. Five years ago, the four agencies formed a consultative group, to exchange information and ideas. Giotto's success depended on Soviet results on the precise position of the comet's nucleus; and this depended in turn on American tracking of the precise location of the Soviet probes.

The consultative group will not pack up its bags with the passing of Halley. At its next meeting, at Padua in November, it will expand its brief and look at other space projects where the four agencies can collaborate. They are already discussing three ideas. A fleet of craft from the different agencies could monitor the activity of the Sun and how it affects the Earth; a large number of radio telescopes in space could combine to "synthesise" a single radio telescope much larger than the Earth; or the agencies could offset the staggering cost of sending spacecraft to the planets or another comet by collaborating on a joint probe. The leading Soviet space scientist, Roald Sagdeev, is canvassing support for a joint unmanned probe that would go to Mars, and bring back samples of soil to Earth.

The scientists have the will, if politicians have the inclination. None of the scientists assembled at mission control in Darmstadt demurred from Sagdeev's summing up: "After many sleepless nights, we must part with the comet, with a feeling of real nostalgia. It has brought a spirit of cooperation that we hope will last longer than the period to the next apparition of the comet." ☐

Poor taste

IN HIS report on potato crisps prepared for SNACMA—the Snack Nut and Crisp Manufacturers Association—Professor Donald Naismith of Kings College, London, nowhere states baldly that crisps are a good thing. He does, imply strongly that the composition of crisps is in line with the recommendations of the recent report on diet and cardiovascular disease from the Committee on Medical Aspects of Food Policy (COMA), and provides statistics to demonstrate this. It is a pity that they demonstrate no such thing.

The principal issue is fat. This, says the report from COMA (in line with just about every nutritional report produced in the past decade) should provide only 35 per cent of total calories, instead of the 40 per cent which is the present average in western diets. And fat, says Naismith's report, makes up only 36·8 per cent of the average crisp. Very nearly bang on line. What the report is cannily phrased to obscure, is that the COMA (and every other report) is talking about 35 per cent of *total calories*. But crisps contain 36·8 per cent of fat *by weight*. Fat is twice as calorific as carbohydrate or protein. Thus fat provides just over 60 per cent of the calories in crisps: almost twice the recommended proportion.

On the other hand, the level of cholesterol in the blood is important. But this is influenced more by the total intake of fat than by specific intake of cholesterol. Naismith is anxious to assure us, that because the fat in crisps is vegetable, it "contains *no cholesterol*" (his italics). True, but irrelevant.

Carbohydrate, according to the COMA et al, should provide 54 per cent of total calories—certainly more than half. The carbohydrate should be unrefined; in particular it should include little sugar. At first sight, again, crisps seem to do reasonably well. As Naismith emphasises, the carbohydrate they contain is "complex" there is no added sugar". And the total carbohydrate content is 40 per cent; less than ideal, but not beyond the pale. However, this figure again refers to percentage *by weight*. The proportion of calories provided by carbohydrate, complex or not, is less than a third.

Fibre is the final major issue. In crisps, says Professor Naismith, fibre "accounted for nearly 12 per cent of the total weight". This is more than the fibre content of wholemeal bread. Again, however, what counts is the amount relative to calories. A hundred grams of crisps containing 12 grams of fibre provides 535 calories. A hundred grams of wholemeal bread might contain only 10 grams of fibre, but it provides fewer than 220 calories. Relative to its calorie content, wholemeal bread is more than twice as fibrous as crisps.

Naismith castigates the "uninformed opinions" of "self-styled nutrition educators" who are "holding to ransom the minds of the British public". Of his own report he states modestly that "If the public is to be educated in healthy eating habits, this is the kind of information they need to assist them". Really? ☐

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Ministers defend beleaguered nuclear industry

Roger Milne

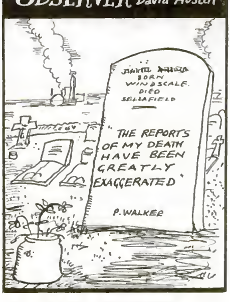
GOVERNMENT ministers moved quickly to the offensive this week to defend the safety record of the British nuclear industry, following damning criticisms by a parliamentary select committee of its methods of waste disposal. But behind the scenes there is a battle in Whitehall between the Department of Energy, which backs the industry, and the Department of the Environment, which shares many of the MPs' concerns.

Departmental rivalry has been fuelled by the MPs' proposals that the environment department should shoulder a major role in the formulation of energy policy. They say it should take over responsibility for the Nuclear Industry Radioactive Waste Executive (NIREX), which is responsible for developing ways of disposing of nuclear waste and choosing sites for dumps. Currently the executive is answerable to Peter Walker's energy department.

Over the weekend, Walker launched an angry attack on the MPs' report, which he characterised as rubbish. "The idea that there is something wrong in reprocessing in a skilfull and effective way to the benefit of jobs and to the benefit of capital investment is a nonsense," he said.

Inside the environment department, however, there is considerable sympathy for the MPs' argument that the reprocessing strategy requires reassessment. Its own policy think-tank echoes the MPs' doubts on the economics of continued reprocessing, which allows spent nuclear fuel to be recycled, but also creates new troublesome waste products. A report from the environment department's Central Policy Planning Unit, currently being considered by ministers, comments: "We would propose that any discussion of a successor to British Nuclear Fuel's thermal oxide reprocessing plant (THORP), currently under construction at Sellafield, should be informed by a more up-to-date analysis of all the costs and benefits involved."

OBSERVER David Austin



Both British Nuclear Fuels and the electricity supply industry, have agreed, albeit reluctantly, to look again at the possibility of long-term storage of spent fuel from Britain's ageing Magnox reactors. This involves a study of the costs of fitting dry stores to power stations and reconsidering the feasibility of drying Magnox spent fuel prior to storage.

Both bodies are convinced there is no viable alternative to continuing to reprocess Magnox fuel while the existing Magnox power stations remain open. On current indications, this means that the 22-year-old Magnox reprocessing building (B205), which is currently at the centre of a safety audit, will remain in business until well into the next century.

Jerry Mason

Sellafield's Pond 5 takes Magnox waste: who wants it next?

The Central Electricity Generating Board told MPs that problems with the cladding around Magnox fuel effectively closed the option of direct disposal of spent Magnox fuel without reprocessing. "Some form of final chemical treatment, such as reprocessing, would still be required," it said.

The industry's commitment to reprocessing was underlined last week by the announcement that the generating board and its Scottish counterpart have finally agreed terms with British Nuclear Fuels for supplying spent fuel from the new advanced gas-cooled reactors (AGRs) to the THORP reprocessing plant. This follows years of haggling. Next month the two boards will sign up to send 1850 tonnes of AGR spent fuel to THORP, starting at the end of the century.

A more pressing problem for British Nuclear Fuels is the pressure to reduce radioactive liquid and airborne discharges from Sellafield into the Irish Sea. That call, backed by the MPs, has been given added urgency by the publication by the National Radiological Protection Board of new guidance on "safe" doses of radioactivity for the general public. The new limit is one millisievert a year, a fifth of the previous limit.

In 1983, the most highly exposed members of the public around Sellafield (known as the critical group) were exposed to 51·5 per cent of the then recommended dose limit. The MPs point out that "at the very least" the Sellafield discharge limit for beta activity was either close to or even in excess of what were then regarded internationally as "acceptable" levels.

They have backed a call from the government's Radioactive Waste Management Advisory Committee that the discharge authorisation at Sellafield should be tightened further, by setting an objective of 0·5 millisieverts as the annual dose limit for individuals in the critical group.

Government departments are currently wrestling with a new authorisation for Sellafield discharges. The MPs want very low limits set for the discharge of actinides (uranium, plutonium, americium, curium), which are not specified in the current authorisation. Their report reflects concern over the build up of radioactivity in the Irish Sea. MPs believe that the old principle of "dilute and disperse" is too crude a basis for dealing with pollution from radionuclides.

The MPs recommend doing away with both the concept of either ALARA (as low as reasonably achievable) or BPM (best practicable means) as conditions of authorisation for dumps. They want new numerical limits for the discharge of both liquid and airborne emissions, which would have the status of fixed-emission limits. "At present," the MPs complain, "the discharge limits too easily accommodate unusual events or accidents."

On current evidence, there is little sign that the government is prepared to be as radical as the MPs would like over this issue—or many other covered in their recommendations.

Twenty-four hours after the MPs reported, the Department of the Environment published its consultants study into the management of radioactive waste. This expressly contradicts the MPs' doubts over the validity of disposing some short-lived wastes in a shallow grave. And it makes it clear that any disposal strategy should keep open the option of disposal on the seabed. This idea was ruled out by the MPs.

The consultants concluded that sea disposal would be the best option for about 15 per cent of the intermediate-level waste expected to arise by 2030. This would include a considerable quantity of detritus from the old Magnox reactors. □

Britain signs up for UNESCO's science

BRITAIN has announced that it will keep up its membership of the Intergovernmental Oceanographic Commission (IOC)—despite leaving its parent organisation, UNESCO, at the end of last year. At a meeting of the IOC in Paris last week, the British government revealed that it is to keep its support for a wide range of scientific organisations that function under UNESCO's umbrella.

Britain left UNESCO, as the US had a year before, complaining of excessive bureaucracy, extravagance and political hostility to Western nations operating under UNESCO's banner of "education, science and culture".

American and British scientists had contested both withdrawals. They said that UNESCO's organisation of international science is indispensable, particularly at the IOC (*New Scientist*, 21 March 1985, p 6).

Britain says that it will also continue to contribute to UNESCO's International Geological Correlation Project, which enables geologists to collaborate across national boundaries. Britain will channel its funds to the project through the International Union of Geological Sciences. It is not clear yet how far this support will exceed Britain's regular contribution to the union, however.

Britain and the US will continue to support UNESCO's World Heritage Convention, which runs important wildlife reserves. And Britain will also contribute £100 000 a year for two years to the International Hydrological Programme. The money for this will come from the Overseas Development Administration, which used to handle Britain's funding of UNESCO, and will be channelled through the Natural Environment Research Council and the Institute of Hydrology, which will use it to support British hydrologists participating in UNESCO projects.

Similarly, UNESCO's programme on Man and the Biosphere will get £80 000 a year, via the Institute for Terrestrial Ecology. Hamish Scular at the Overseas Development Administration says that Britain should announce all its contributions to UNESCO's science in the next few weeks.

The details will be awaited with interest. Last year, the US announced that it would continue to fund the IOC, but last week in Paris the pledge was reduced to $200 000 for 1986, a quarter of the planned amount.

The US is scaling down its contributions to UNESCO's science far more than Britain. Sorin Dumitrescu, UNESCO's deputy assistant director-general for science, estimates that British support for UNESCO's science will amount to about half its previous annual contribution to UNESCO as a whole. The contribution of the US has dropped to a tenth of what it was.

The dozen or so British scientists working at UNESCO in Paris can keep their jobs, but no new ones will be recruited, says UNESCO. As a consequence of leaving the organisation, Britain and the US will lose their say in planning the direction of international science at UNESCO. UNESCO meanwhile must cope with a greatly reduced science budget, largely as a result of the US's actions. An early casualty has been the journal *Impact of Science on Society*, which has lost its full-time editor. □

Potholing down Britain's roads

BRITAIN'S roads deteriorated sharply last year, according to an official survey of road maintenance. All roads were in a worse state than they were when the survey by the Department of Transport and local authorities started in 1977, and trunk roads were 20 per cent worse than in 1977.

Financial cutbacks in road maintenance are one of the main causes of this deterioration. Most roads improved between 1977 and 1980, a period when spending remained at a relatively high level. Since 1980, roads have worsened and last year there was a marked increase in the number of cracks that have appeared. The British Aggregate and Construction Materials Industries says spending on maintenance "had not been enough" and that the "accumulated neglect was taking its toll".

Another factor is the increasing number of heavy vehicles using main roads. The maximum weight of lorries was increased in 1983, and many lorries are overloaded. A survey by the Transport and Road Research Laboratory, which was published last year, found that one in five of the heaviest lorries on the M1 was overloaded.

Peter Bottomley, the junior minister, called the survey's finding disappointing but said that the government wanted to catch up on the backlog of maintenance by "the early 1990s".

The survey found the worst increase in damage on the country's main roads, which are used most by heavy lorries. Trunk roads, maintained by central government, were 20 per cent worse on the survey's index of all defects, than in 1982.

The index is an attempt to combine seven different defects in the road surface, including the rutting of wheel tracks, potholes and crumbling of the road. □

Councils want to see addresses of dangerous factories

LAST SATURDAY a man died and two more were injured when a small chemical works at Peterlee in northeast England blew up. The same day, 50 children were rushed to hospital after a leak of chlorine at a swimming pool in Tenby, Wales.

The Health and Safety Executive (HSE) is compiling a list of 34 000 factories, chemical stores and other places where more than 25 tonnes of a wide range of toxic and explosive substances are regularly stored. But it has run into a political storm from local councils who want the addresses published so that their planners can take them into account when deciding, for instance, whether to allow houses to be built next door.

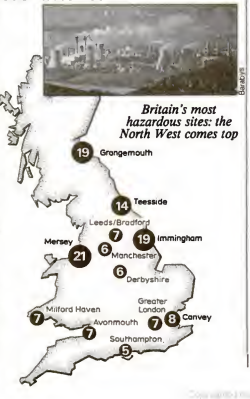
The row between the HSE and local authorities has developed at a time when the HSE has taken steps to release more information on hazardous sites. Last week, the executive released details on Britain's 200 most dangerous plants. The map (right) shows the biggest concentrations of hazardous plants are on the estuaries of the rivers Thames, Humber, Tees, Mersey, Severn and Forth.

The executive says it will compile a bigger register of dangerous sites, which will be available to the public. However, the executive says that it also wants companies to put up warning notices on smaller premises storing 25 tonnes or more of dangerous substances.

Councils are concerned that arrangements for full-scale emergencies only apply to a limited number of "top tier" plants. The councils want the HSE to review the position of premises storing a number of different substances, all below accepted "threshold" levels for each substance but which together could constitute a dangerous "cocktail" in the event of an accident.

In addition, the councils are pressing Whitehall to change the regulations to tighten up the rules on the storage of sodium chlorate, sulphur trioxide, oxygen and 50 substances which pose either flammable or explosive risks. The AMA intends to carry out a series of hazard surveys to support its claim that too many firms are slipping through the safety net.

● ICI's Grangemouth plant in Scotland has the distinction of being Britain's first plant to trigger the emergency response provisions of the recently introduced Control of Industrial Major Hazard Regulations. A bromine leak last month resulted in a full-scale emergency alert at a nearby housing estate. □



Britain's most hazardous sites: the North West comes top

Californians can kill pumas for fun

Bruce Coleman

Puma hunters ready to pounce

CALIFORNIANS may be able to kill pumas for sport this autumn for the first time in 14 years. Pumas (*Puma concolor californica*), also known as mountain lions or cougars, are the largest species of wild cat on the American continent, apart from jaguars. The Governor of California, George Deukmejian, cleared the way for trophy hunting of pumas last year when he vetoed a bill that would have continued their protected status.

Until 1963, California paid a bounty for each puma killed in the state. Hunters slaughtered more than 12 000 under this programme. When the bounty system ended, hunting for sport continued.

Puma hunters use dogs to trap their prey in trees. Once killed, the carcasses, which have no commercial value, are often left to rot. In 1972, public outrage over the hunting led to the state giving the species protected status, although farmers are still allowed to kill pumas that threaten their livestock. There are no exact figures on the number of pumas left in California, but the animal is not on the list of endangered species.

Officials from the state's Fish and Game Commission estimate that there are fewer than 5000 pumas still alive.

California's hunters argue that pumas are killing deer, another popular game animal. One proposal now before the California Fish and Game Commission is to kill every puma in 250 square miles (650 square kilometres) of Sierra National Forest in Fresno County to see what effect that would have on the local deer population. Because the experiment would run for several years, pumas from adjacent territories who move into the area would also be killed.

Conservationists deny that pumas have a significant impact on the numbers of deer. Sharon Negri of the Mountain Lion Coalition says: "Hunters and poachers kill many more deer than mountain lions."

At a public hearing earlier this month, experts in the state's Department of Fish and Game recommended to the commission, the political appointees who will make the final decision, that the resumption of puma hunting be delayed until a proposed study is completed next year. But several hunting groups asked that both programmes go ahead this year. The Mountain Lion Coalition has promised to take the state to court if hunting is allowed. The commission will announce its decision on 25 April. ☐

Plan unveiled to exploit military technology

MILITARY research laboratories in Britain are to play host to civilian scientists under a scheme hatched by the Department of Trade and Industry (DTI) to boost the spin-off from electronics defence work. This week, Geoffrey Pattie, the Minister of State for Industry and Information Technology, announced the first two projects in a series of National Electronics Research Initiatives: collaborative projects involving groups of company researchers seconded to work with their military counterparts.

The first projects, involving work on pattern recognition—the business of deciphering signals from sensors—and printed—circuit boards made out of silicon, will take place at the Royal Signals and Radar Establishment (RSRE) in Malvern. Each project will cost £1 million to £2 million, and will involve up to 20 reseachers. The cost will be shared by the DTI and the companies taking part in the projects.

The project on pattern recognition will include researchers from 10 companies, with each contributing one or two people. The project to make silicon circuit boards will involve a further eight firms, with several companies contributing to both projects.

"This is an evolution of our role in seeding technology in industry," said Alan Fox, deputy director of applied physics at RSRE Malvern. "We are going beyond serendipity to join civil and military programmes."

The idea of joint research carried out at a single centre will be the model for other DTI schemes, said Pattie. The DTI's Alvey Programme of computer research has been criticised on the grounds that researchers from different organisations have no national laboratories to work in, but have to spend time travelling to each other's workplace.

Two more projects under the initiative are due to be announced before the end of the year. They will be in the fields of advanced semiconductor research and molecular electronics—the technique of building electronic devices from organic materials.

Although there are already several collaborative research programmes run by the DTI, Bill South, technical director of Philips, one of the companies involved in the start-up schemes, said there was a need for "an additional mechanism" to speed up technology transfer and overcome the "difficult problems of collaboration". ☐

● **Pattie interview, p 25**

Massive museum opens

THE LARGEST science museum in the world opened last week in Paris. Thousands of people poured in for the museum's first show: the encounter between Giotto and Halley's Comet, broadcast live from the museum by French television.

The museum covers three hectares, stands 47 metres high, and could contain three and a half Pompidou Centres. It holds over 9000 square metres of exhibition space. Only a third of the exhibits are built, many of which are still unfinished.

The huge space is lit through glass domes on the roof, via computer-controlled mirrors. The four sections, on earth and the universe, life, materials and communications will feature 1000 computer screens and terminals.

The museum cost $650 million, five times more than originally estimated, and will cost $90 million a year to run. It is hoped than 30 per cent of costs will be recovered, partly through selling devices designed for the museum under licence. ☐

Spaghetti bypass

BRITAIN'S Department of Transport is designing the ultimate motorway—a bypass for Spaghetti Junction. The motorway, which is officially termed a northern relief road for the M6, will be one of the most expensive in Britain. It will be 35 kilometres long and will cost £130 million.

The motorway will bypass the elevated sections of the M6, which have had considerable maintenance problems. The new road is virtually certain to be the subject of a lengthy public inquiry and construction work is unlikely to start before the mid-1990s. ☐

Hormone ban challenged

BRITAIN will challenge a directive from the European Community banning the use of growth hormones in beef. Last week, Michael Jopling, the Minister of Agriculture, said he wants the European Court of Justice to annul the directive because it was adopted with "lack of regard for relevant scientific evidence".

He said that it is up to farmers to decide whether they should use hormones to fatten cattle "until a ban is implemented". ☐

London ecology saved

LOCAL authorities are banding together to promote nature conservation in London. So far, 18 of London's boroughs have formally agreed to support the ecology unit set up by the Greater London Council (GLC), which is to be abolished at the end of this month. For £10 000 a year each, the boroughs will be able to draw on the unit's eight ecologists and three administrators for advice, for instance, on how to rehabilitate derelict land or manage existing sites.

Eleven other boroughs, such as Bromley and the City of London Corporation, have refused to support the ecology unit, David Goode, the GLC's chief ecologist, suggests that such refusal is short-sighted. "The unit could provide boroughs with considerable services for less than the cost of hiring just one ecologist", he says. ☐

Wildlife fund's anniversary

THE WORLD Wildlife Fund is launching a major new campaign today (Thursday) to mark its first quarter-century. Instead of the emphasis on endangered species, characterised by the familiar panda logo, the main thrust of the campaign will be the protection of habitats in the world.

The fund plans 25 projects. In Britain, much of the work will concentrate on urban areas as well as a special help for the Somerset Moors and Levels, which are expected to be designated shortly as one of six Environmentally Sensitive Areas under new European legislation. ☐

Painkillers probably cause perforated ulcers

NEW EVIDENCE suggests that certain common painkillers cause gastrointestinal bleeding, particularly among the elderly. Two studies by researchers from Nottingham University Hospital, published in last week's *The Lancet*, show that the number of prescriptions for such drugs has trebled since 1967. At the same time, the number of older people, particularly women, suffering from bleeding ulcers has doubled.

The research is the first systematic study of the possible link between non-steroidal, anti-inflammatory drugs (NSAIDS) and perforated ulcers. Britain's Committee on Safety of Medicines (CSM) has, as a result of the findings, issued new warnings to doctors advising them to avoid prescribing NSAIDS to the elderly and to patients with a history of ulcers. The committee will publish its own analysis of the adverse reactions to the drugs next month.

Older people seem to be at a greater risk of bleeding ulcers as a result of taking NSAIDS than other age groups. One of the reasons could be that more than half, perhaps as many as 70 per cent, of all NSAIDS prescriptions are for people over 60. For this reason, Kevin Somerville and his colleagues in the hospital's Department of Therapeutics investigated 230 patients over 60 years of age suffering from bleeding ulcers. Compared with two control groups, the researchers found that these patients were more than twice as likely to have taken NSAIDS.

The Nottingham group also found that although there had been an overall decline in hospital admissions for bleeding ulcers over the past 20 years, there had been a sharp rise in admissions of the elderly, particularly women.

Another study by Robert Walt, also from Nottingham University Hospital, found that between 1958 and 1982 cases of gastrointestinal bleeding among the over 65s rose from 319 to 1059 a year. Meanwhile, the number of NSAIDS prescribed to this age group increased by 4·4 million a year.

The researchers say of the figures suggest that for every 19 000 prescriptions there is one perforated ulcer —a rate too low to be detected in post-marketing surveillance. Nevertheless, the researchers argue, this rate "would plainly still be important in view of the high rate of prescribing NSAIDS". Somerville's study suggests that "there might be about 2000 cases of bleeding induced each year with, given a death rate of 10 per cent, about 200 deaths".

Professor Bill Inman, director of Southampton University's Drug Surveillance Research Unit, says the figures must be read with caution: "We are probably trading a handful of lost years due to adverse effects for millions of more comfortable years of benefit from the use of NSAIDS."

The CSM says that NSAIDS account for 5 per cent of all prescriptions, but cause 25 per cent of adverse reactions that are reported to it. These include 3500 reports of bleeding or perforated ulcers, 75 per cent of them in the over-60s. Of 600 fatal cases, 90 per cent were over 60. ☐

Cheap way to banish dioxin

SWEDISH researchers have found that emission of dioxin from burning waste could be drastically reduced without the need for expensive high-temperature incinerators. They have shown that removing hydrochloric acid from the incinerator, by adding a chemical buffer, can reduce emissions of dioxins at temperatures as low as 550° C.

To avoid dioxin emissions waste needs to be burned at temperatures in excess of 1000° C, while ensuring that an adequate air supply is always well mixed with the refuse, Rechem International was recently forced by public concern over safety to close down one of its plants, and now operates its Welsh incinerator at 1100° C with a 12-20 per cent excess of oxygen. The refuse is kept in these conditions for about four seconds, twice the recommended period.

Goran Eklund, Jorgen Pederson and Birgitta Stromberg, at Studsvik Energiteknik in Nykoping, Sweden heated a mixture of phenol and hydrochloric acid for five minutes at 550° C. This resulted in the emission of large amounts of chlorinated organic compounds. The emissions look very similar to a list of pollutants found in the flue gases from municipal incinerators—including tetrachlorodibenzodioxin, which is usually called dioxin. They found that the formation of these compounds depended on the concentration of hydrochloric acid. When this fell to very low levels, no chlorinated compounds were produced.

Hydrochloric acid is produced in incinerators by, for example, burning chlorinated plastics. And there are high levels of phenol and its precursors in household waste.The Swedes argue that this could be the source of chlorinated organic compounds, especially at temperatures below 1000° C. Such conditions can occur in incinerators run by crematoria and hospitals. Wooden coffins contain wood preservatives based on phenols.

Fortunately, the Swedes suggest a simple remedy. By adding a suitable alkali to the incinerator's fuel, the acid can be neutralised to help to stop the dioxin-forming reaction. It would also rule out the need to go to high temperatures, and so save on fuel bills. ☐

Artificial heart saves woman during transplant operation

EUROPE's first successful artificial heart implantation was carried out last Thursday in Austria. The team of doctors responsible for the operation was led by the man who has been developing the polyurethane heart over the last 12 years, Professor Felix Unger.

The decision to use the heart was made very quickly when a hospital in Salzburg could not to find a suitable donated heart for a 26-year-old mother of two who had a congenital heart condition. Last Thursday morning, the patient's aeortal valve began to close and it became clear that she would have died by the evening unless something was done, Unger said. "We did not undertake this operation to create a sensation—it was rather a despairing attempt to save a person's life."

The woman's age, her two children and the fact that all her other organs were in excellent condition also contributed to the decision to attempt the implantation.

Life saver: Austria's first artificial heart

Felix Unger/Walkner

Unlike the four artificial hearts implanted in the US, the Austrian heart was used only as a temporary replacement until a compatible donated human heart could be found. Just over 24 hours later, an aircraft carried a donated heart from Stuttgart, and was then transplanted into the woman. Doctors said that the patient was in excellent condition while the artificial heart was functioning.

Until Thursday's operation, the heart, which could in theory function within a human body for much longer, had only been tested on calves.

Unger and the heart specialist, Professor Ernst Wolner, who assisted during the operation, do not yet intend to use the heart as a permanent replacement. ☐

New cholera vaccine will be tested on volunteers

THE FIRST human trials of a genetically engineered vaccine for cholera and typhoid will begin in Adelaide, South Australia, next week. The vaccine, which is taken orally, should give lifelong immunity against cholera, which kills millions of people in Bangladesh, India, Pakistan, Sri Lanka and Africa every year.

Professor Derek Rowley from Adelaide University has worked on the vaccine since 1980 and has successfully tested it on animals. He has approval from the South Australian department of health to carry out the human trials, which will take place at a hospital in Adelaide once used to treat infectious diseases.

The tests are expected to involve one-week trials on six volunteers in order for Rowley to gauge the optimum dose of the vaccine and its effectiveness.

If the trials prove positive, the vaccine will be tested in Baltimore, in the US, at the end of the year. Volunteers there will be exposed to the disease after immunisation. The final field trials will take place in Bangladesh, probably in 1988, when several hundred thousand people will be given the vaccine.

The vaccine is made by taking genes of the typhoid and cholera bacteria and cloning them inside harmless bacteria. These bacteria then produce the specific antigens which stimulate the human immune system to produce antibodies able to recognise infection by cholera and typhoid.

The vaccine's main advantage over existing vaccines is that it gives lifelong immunity and is effective against very heavy doses of the disease. Commercially available vaccines give only limited immunity for upto six months and are not always effective against heavy infection.

Existing vaccines rely on dead bacteria to provide the immunity, and they also produce uncomfortable side effects, such as fevers, caused by toxins associated with parts of the dead bacterial cells. They also tend to suppress the body's natural immune system, particularly in the gut where protection is needed most.

Adelaide University and a local pharmaceutical company, F. Faulding, have formed a joint company. The company hopes to raise venture capital on the stockmarket to finance the vaccine's development, which Rowley estimates will cost around $50 million. This will probably require the help of a multinational company. ☐

Cholera in the Third World: a vaccine could save millions of lives

Early results show drug helps patients to fight AIDS

A SHORT trial of a drug to counter AIDS has produced encouraging results with 19 patients. The drug is azidothymidine (AZT) and has been developed by the Wellcome Laboratories in Britain. But scientists are a long way from developing a proven safe drug against AIDS, however—and further still from developing a vaccine that could protect people from infection by the AIDS virus.

The trial was conducted in the US by the National Cancer Institute. After using the drug for six weeks, 15 of the 19 patients showed increases in the number of T-lymphocyte cells in their blood. The number of cells becomes seriously depleted in AIDS patients. The group also showed an average gain in weight of 2·2 kilograms, according to the first reports of the trial, published in *The Lancet* last week.

Robert Yarchoan, of the National Cancer Institute, warned that much longer studies will be needed before he can be sure "whether AZT will affect disease progression or survival" in AIDS patients.

Rash predictions from the US government in 1984 that a vaccine against AIDS would be developed by this year have proved hopelessly optimistic. There will not be a vaccine available for testing on humans before 1988, at the earliest. Its effectiveness will not be clear for several years after that, because of the length of time that the virus can lie dormant in cells.

So the government has switched its attention to the potentially much quicker task of developing a drug to counter the effects of AIDS. It wants to set up, a series of National Cooperative Drug Discovery Groups, with teams of perhaps 2000 volunteers for clinical trials.

AZT is the first drug to start "phase two trials" in which its effectiveness on humans is tested. But five other drugs are only months behind, undergoing "phase one" trials to test for a safe dose.

AZT will soon be ready for "phase three" trials, involving large numbers of people at varying risks of catching AIDS. These trials may last a year and, if they are successful, the US Food and Drug Administration has promised that it will allow a speedy transfer of the drug to the marketplace.

The search for a vaccine depends on the discovery of a substance that will stimulate the production of antibodies to the AIDS virus. The most promising of these antigens so far is gp120, a protein that forms the coat of the AIDS virus.

Scientists have tested it on the cells of animals to see if it elicits the right antibodies, and so far they have been successful. But, up to now, gp120 has been taken from, and tested with, only one strain of the AIDS virus. Even if other strains work as well and if further studies—inoculating chimpanzees and "challenging" the vaccine by giving the animals doses of the AIDS virus—are successful, there may still be a problem in producing gp120. It is difficult to isolate in quantity and may have to be recreated by genetic engineering.

A final problem for researchers before they begin tests on humans could be the availability of chimpanzees on which to conduct some of their animal trials. Chimpanzees are used because they are the only species of primate that can contract the AIDS virus without ever getting ill. Nevertheless chimpanzees are an endangered species and some animal-rights activists say that the animal is too closely related to man to be an acceptable laboratory animal.

The solution could lie with a strange colony of several hundred chimpanzees being kept in quarantine across America after their use in studies into hepatitis. The chimps have been kept in quarantine because nobody knows whether they are still carriers of the disease. ☐

Science fair planned for Britain

BRITISH scientists and engineers will have a chance to come out of their closets in 1987. A charitable trust is about to announce plans for the largest science and technology fair ever seen in Britain. Researchers from universities, schools and other non-profitmaking organisations will have free space in the show.

The British Science and Technology Trust last week agreed to take over the display ground at the Royal Aircraft Establishment, Farnborough, to stage the show in 1987. The site is the venue for the Farnborough Air Show, Britain's largest trade fair, which is held every two years. If all goes well, SciTech 87 will be the first in a series of shows that will alternate with the air show.

The idea comes from Paul Cook, a laser engineer, who says he wants to encourage more young people to choose engineering science as a career. "You hardly ever see a scientist or engineer held up to high esteem. Our whole idea will be to reverse that."

Cook will allow only British companies, or companies "with a British research base", to hire space in the 42 000 square metres of pavilions at Farnborough. Much of the space will be open to exhibits from universities and colleges. ☐

Norwegians protest over gag on research

Fred Pearce, Oslo

BRITISH scientists are being accused of trying to stifle the first results of a three-nation study into whether acid rain is killing Scandinavian fish. They have refused to allow the production of annual reports on the study's work, which is already a year behind schedule and will not yield final results until 1990. Norway's environment minister, Rakel Surliem, is expected to raise the matter in talks with British ministers in London this week.

The five-year study, the Surface Water Acidification Project (SWAP), was announced at the Royal Society in London in 1983. It costs £5 million and is being financed jointly by the Central Electricity Generating Board and the National Coal Board. It involves scientists in Britain, Norway and Sweden.

Late last year, Britain's Prime Minister, Margaret Thatcher, angered her Norwegian counterpart, Kaar Willock, by saying that Britain would not act to reduce sulphur pollution from its power stations. She said she would wait until the SWAP programme had established whether the resulting acid rain is responsible for the deaths of fish in thousands of lakes and rivers in southern Scandinavia. Britain is responsible for 17 per cent of the acid rain that falls on Norway, more than any other country, including the Norwegians themselves.

Early results from the project appear to underline the role of modern air pollution in making lakes acid. Rick Battarbee at Imperial College, London, has demonstrated from studies of organisms in the sediments of acid lakes, that the acidification has occurred in recent decades. And a large experiment in Norway, in which rain is collected and cleaned of modern pollutants before being sprayed onto soils, has already shown that the water percolating into streams becomes less acid.

So Scandinavian members of the project's management committee, which met last month, were angry that the five British scientists on the committee used their majority to reverse a previous decision to publish annual reports on the progress of the project. Lars Walløe, professor of physiology at the University of Oslo and a member of the management committee, says: "The formal reason for the decision was that there is too much work involved collating the results. But the effect is that the new results will not receive the attention they deserve."

The scientists involved in the project are free to publish their findings in scientific journals. But their work will not now have the SWAP "seal of approval" until 1990.

There is little chance that the committee will change its mind. Regular quarterly meetings have now been abandoned. The next meeting of the management committee will not be until June 1987. And, according to Walløe, there may not be another until the presentation of results in March 1990. ☐

Vegas may go on to meet an asteroid

SOVIET scientists may use the two Vega spacecraft to take the first pictures of an asteroid. This will make them the only spacecraft apart from Voyager 2 to encounter three different objects in the Solar System. The Vegas dropped balloons and landed craft on Venus as they passed the planet last year on their way to Halley's Comet.

Ronald Sagdeev, a Soviet mission planner, says that the Vegas each have enough fuel to change their speeds by a few hundred kilometres per second. Soviet scientists are now discussing possible targets. Sagdeev says: "We were too superstitious to discuss this before the Halley encounter". The Vegas could go to one of the older comets that we know; or the Soviet scientists may wait until a new, young, comet appears and intercept that.

The third possibility is to take the first close-up pictures of an asteroid. The cameras on both Vegas are still working, and Vega-1 has in infrared detector that would reveal information on the composition of the asteroid's surface.

The US had planned to take the first picture of an asteroid this December, when the Galileo probe to Jupiter passed the asteroid Amphitrite. But this project has been delayed at least a year by the grounding of the space shuttles.

● Officials at the European Space Agency (ESA) are expected to make a decision about possible future missions for the Giotto spacecraft today (Thursday) or tomorrow. Last Thursday, Giotto survived a fierce dust storm as it passed by Halley Comet and collected data about the comet's composition.

Initial reports from ESA show that the solar arrays, that provide the craft with power, and the mechanism that keeps the crafts antenna pointing towards Earth are working.

Mission controllers believe, however, that the star mapper that is vital for Giotto's navigation may have been damaged during the encounter. Also, the temperature at the lower end of the spacecraft is increasing. This could be due to damage to the protective thermal blanket by dust particles during the encounter.

During the past few days, staff at the European Space Operations Centre in Darmstadt, West Germany have carried out tests to assess in detail the health of the craft. Most of the experiments on the craft are in working order, but an attempt to start the camera last Friday failed. ☐

How fleet-footed Gertie won the dinosaur race

EARLY plant-eating dinosaurs survived because they could outrun their lumbering carnivorous enemies, the thecodont reptiles. Reconstruction at Berkeley in California, of the world's oldest dinosaur skeleton nicknamed Gertie, has revealed that early dinosaurs had surprisingly long hind legs. "Gertie must have done a lot of running," Robert Long, a palaeontologist at Berkeley, said.

Gertie went on public display for the first time this week at the Museum of Palaeontology, part of the University of California at Berkeley. The partial skeleton, embedded in a slab of rock, was lifted out of Arizona's Petrified Forest National Park last summer by helicopter (*New Scientist*, 13 June, p 9).

Palaeontologists at Berkeley have spent the last few months separating the bones from the rock. They have also examined bones from Gertie's contemporaries, which have been languishing in storerooms at Berkeley since the 1920s. Many of the bones have never been assembled before so, for the first time, scientists are learning about what some of the animals looked like. The collection also includes about 200 species of fossilised plants, including varieties that Gertie ate.

The palaeontologists are piecing together what the world was like 225 million years ago when Gertie, a prosauropod, was alive. At the time, the continents were fused and what is now Arizona was 2500 kilometres closer to the equator.

The region that is now the Petrified Forest was, during the Triassic period, dominated by ferns and towering conifers. Flowering plants did not exist.

The US National Park Service has recently commissioned Berkeley and the Natural History Museum of New Mexico to prepare glass-fibre casts of four almost complete skeletons found at the Petrified Forest so that they can be put on permanent display at the park.

Gertie, whose nickname derives from the first animated cartoon of a dinosaur made in 1909, weighed about 67 kilograms and was 2·4 metres long. It is a new genus and species of prosauropod and may have later evolved into the huge brontosaurs.

Long's group intends to return to the national park where Gertie was found in June. ☐

Ian Anderson

Survival of the fastest

Pattie wants a science policy for Britain

Ros Herman

THE BRITISH government is on the way to formulating a national science policy, according to Geoffrey Pattie, minister of state at the Department of Trade and Industry (DTI). And it could mean money being taken away from the Ministry of Defence and given to the DTI. This is a move favoured by Pattie, who is a former defence minister.

It is the first time that a senior government minister has admitted that the government is reviewing the pattern of spending on R&D.

Ever since the ill-fated "white heat of technology" propounded by the Labour government during the 1960s, successive governments have failed to formulate a national science and technology policy for Britain.

A new set of ground rules was laid down in 1972 by Lord Rothschild, in a White Paper called *Framework for Government R&D*. This established the "customer-contractor" principle, under which each government department "buys" the research it wants from the appropriate government laboratory or other appropriate organisation. The system has in recent years come under fire because some departments, notably the Ministry of Defence (MoD), have dominated the direction of government R&D.

As far as the DTI is concerned, the principle has worked largely through a series of requirements boards, committees that consist mainly of representatives of the large companies, with one board to each sector of industry.

Other ministries, too, decide their own needs for R&D and allocate resources from the overall budgets given to them by the Treasury. In principle, no ministry has the right to question the way any other ministry plans or executes R&D. This means that there is no mechanism for developing a national policy for R&D that takes into account the work of all the ministries.

DTI

Pattie: wants policy reversal

The fact that Pattie, who has special responsibilities for innovation, favours a national science policy indicates that the government is finally waking up to recommendations made several years ago. In 1982, the House of Lords' Select Committee on Science and Technology said that the government should formulate a national policy for R&D. The committee also recommended that government should appoint a minister of science and a small secretariat to formulate a policy.

The government took up the second suggestion, but did not appoint a new minister. Instead, the Prime Minister, Margaret Thatcher, took on the job herself. Since 1983, the science group within the Cabinet Office, led until recently by Sir Robin Nicholson, has published three *Annual Reviews of Government R&D*.

Each year, more information on spending by government departments has been included. The 1985 volume also contained information on how much industry spends on R&D, and international comparisons of levels of funding. It was the first real attempt at analysing government R&D.

Pattie says that it must have been clear that the very existence of the Annual Review was the beginning of the end for the Rothschild principle. So far, though, government has said very little about any explicit changes in policy.

Pattie told *New Scientist* that he wants the DTI to receive a bigger share of the money spent on R&D. In particular, he expects funds to be transferred from the MoD, where he was Minister of State for Defence Procurement, so has a good idea of the amount of money at the MoD's disposal.

Pattie cites the example of R&D in electronics. Here, he thinks, the MoD has too large a say in the direction in which research is going because the ministry accounts for most of the money spent on it.

His major concern is investment in "enabling technologies", or the set of techniques that need to be developed in order to produce a certain type of equipment. An enormous outlay is needed to develop these techniques, and companies have to invest heavily well before they can even think about developing specific products.

For these reasons, government has to contribute, sometimes on a massive scale, to such development. Where in government the money should come from is not always obvious. In Britain, most government funding for such work in electronics comes from the MoD. Inevitably, then, the priorities and objectives are set by MoD officials.

Pattie thinks that those concerned with developing products for ordinary consumers should also be able to influence the development of "enabling technologies" at an early stage. This, he thinks, could be brought about by channelling more of the funding through the DTI.

Pattie has instigated a series of quarterly meetings in which the DTI brings together 30 senior investors from the City with R&D managers from industry. "In certain cases it was only in quite recent times—and I'm talking about months—since people like analysts had been able to get into companies at levels other than the finance director." Now there is much more direct access. R&D managers are beginning to expect some technical understanding from their City visits, Pattie says.

The DTI is listening to industry and acting on what it hears, Pattie says. It is pressing the Treasury to allow more tax concessions to encourage such investment. And Pattie would like to see the Stock Exchange regard it as "best practice for companies to declare their spending on R&D".

Pattie says that he is reasonably happy with the way the DTI distributes its funds between different industry sectors. □

Dugongs return to Persian Gulf after fears of extinction

THE DUGONGS of the Persian Gulf have not, as feared, been wiped out by oil spills. A herd of them has been spotted near the Bahraini island of Hawar. Scientists in Saudi Arabia think it could contain as many as 500 animals.

Dugongs are vegetarian, aquatic mammals related to manatees. In January 1983, Iran's offshore Nowruz oil well was damaged by Iraq during the Gulf war. Three months later, 40 dead dugongs, along with many turtles, snakes, and birds, were washed up on Saudi and Bahraini beaches. Oil had apparently caused the deaths, and there were fears that the Gulf's population of dugongs, which was thought to number about 50, had been destroyed (*New Scientist*, 21 July 1983, p 180).

Now Walter Vreiland of Bahrain's Environmental Protection Bureau says that the deaths probably occurred a month before the oil spill reached Bahrain.

Scientists in the area are amazed at the size of the newly discovered dugong herd. It is second only to the world's largest herd in Australia. The discovery shows, they say, how poorly the ecology of the Gulf is understood. One problem is that military authorities bar scientists from many areas.

Bent Nielsen, of the UN Environment Programme in Nairobi, says a survey of wildlife in the Gulf is being planned. Meanwhile, the effect of oil spills on the Gulf's wildlife remains obscure. Infrared images taken by American satellites, which purported to show the extent of the 1983 spill, are dismissed by scientists in the area as having revealed little more than seasonal gradients in temperature and algal blooms. □

Bruce Coleman

Dugongs: not gone yet

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SCIENCE

Monoclonal antibodies aim at smaller targets

Steve Wilson

NOT SO LONG ago, monoclonal antibodies were hailed as "magic bullets" in cancer therapy. Now, it looks as if they can be used to combat only very small amounts of tumour—that is, according to recent work carried out at the Institute of Child Health (ICH) in London.

Until now, studies have shown that monoclonal antibodies can home in on human tumours which have been grafted into mice. Researchers hoped that this might help them to target drugs or radiation into tumours in human patients. The trouble is that what works for mice is very inefficient for humans.

John Kemshead at ICH and Hugh Coakham at Frenchay Hospital, Bristol, have given doses of antibodies labelled with a radioisotope of iodine to a group of adults suffering from a very malignant type of brain tumour, and to children suffering from the childhood tumour neuroblastoma. They looked at the amount of radio labelled antibody concentrated in the cancer at the time of surgery. They found that where the tumours formed large lumps, not enough antibody was taken up to have any therapeutic effect.

Kemshead admits that this is not what he had expected. The antibodies are made by immunising mice with human fetal brain cells and selected to bind to neural tumours. In mice they do, but in the human patients they were taken up only fractionally more strongly than antibodies which had no ability to recognise the tumours—indicating how poorly they were targeted on the cancer cells. However, the brain may be a difficult case, says Kemshead. The blood vessels in the brain differ from those in other parts of the body. These vessels are the ones that supply the tumour and though their properties do become modified, they might still restrict the entry of antibodies into the cells of the tumour.

But one problem common to all tumours, not just brain tumours, is that they take up only a minute amount of antibody—about 0·001 per cent of the injected dose per gram, which is not nearly enough to be effective. It seems that the sheer size of the antibody molecule—which weighs in at 150 000 daltons—restricts its passage through narrow capillaries to the tumours.

Kemshead and his team of researchers have tried to get round this by using enzymes to cut off part of the antibody's tail—which consists of two heavy molecular chains. This gets rid of a third of the molecule's weight, but still leaves its two antigen-recognising arms to grapple with the cancer cells.

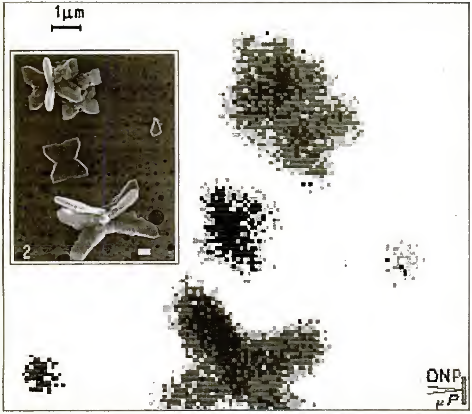
In human patients, rapid clearance of antibody molecules presents another problem. The human body recognises the antibody as foreign and clears it more rapidly with each dose that is given. In one instance, a single dose kept a child's bone marrow free of tumour for eight months, but when the researchers tried to repeat the dose the antibody was excreted too quickly to have any effect—making it virtually a "one shot" treatment.

At present, Kemshead says, there seems to be no way of getting more monoclonal antibodies into large tumours, but he believes they still have a vital role to play. Treatment to mop up micrometastases, the tiny amounts of residual tumour left after surgery or radiotherapy, can be difficult and risky. It often requires high doses of external-beam radiation, which can be particularly dangerous for children because it can cause sterility, retarded growth and secondary malignancies. Yet, if left untreated, these patients will almost certainly relapse and die. Antibodies could help in these cases.

Conventional treatment combines high doses of chemotherapy with high doses of external-beam radiation. The combination kills not only the child's tumour, but also its bone marrow, so it is necessary to remove some marrow first in order to replace what will be destroyed during therapy. The antibodies can ensure that the stored marrow is free of tumour cells. Kemshead would also like to see them used as an alternative to the high-dose radiation.

The researchers have already shown, using another method, that the antibodies can deal with small quantities of tumour. In December 1984 they treated an adult who had residual tumour cells spreading down his spinal column and root nerves, causing him a great deal of pain. After they injected the antibody directly into the spinal fluid—the man made what Kemshead describes as "a remarkable recovery". The team is now applying the method to other patients. □

Proton probe sets a new world record



OXFORD University's scanning proton microprobe (SPM) has reached new levels of resolution and has mapped for the first time the distribution of a specific element in a sample at a resolution of less than 1 micrometre (1 μm). The probe, developed by Frank Watt and Geoff Grime in the nuclear physics department, works by scanning a finely focused beam of energetic protons across the sample. The protons induce atoms to emit X-rays, and by measuring the wavelengths of these X-rays it is possible to identify specific elements.

The picture inset here is an electron micrograph of barium sulphate crystals. (The white bar is 1 μm long.) The main image is an SPM scan of roughly the same area. This shows the distribution of sulphur; black areas show where there is most sulphur, pale grey areas where there is least. The important feature here is that the SPM reveals differences that occur on a scale of less than 1 μm. Indeed, Watt and Grime estimate that the spot size of the proton beam is less than 0·5 μm square—a world record for scanning proton analysis that promises to open up a new field in mapping elements within cells. □

Giraffes and snakes get to grips with gravity

WHAT DO giraffes and climbing snakes have in common? The answer is that both have problems with their circulation—gravity affects the flow of blood around their bodies. But, the mammal and the reptile seem to have solved the problem in similar ways.

P. Johnson/NHPA

H. Reinhard/B. Coleman

Head-down or head-up, the giraffe and the tree snake get round gravity

An average giraffe is 5 metres tall; its head is about 2·5 metres above its heart. Blood leaves the giraffe's heart under unusually high pressure. In the past, biologists thought this was necessary to overcome the effect of gravity which might hinder the blood flow to the brain. But, in a new review, Henry S. Badeer of Creighton University School of Medicine. Omaha, has shown that this interpretation is probably wrong (*Comparative Biochemistry and Physiology*, vol 83A, p 207).

Badeer points out that the blood supply to the brain is analogous to a siphon: it rises in a closed circuit from the heart, passes through the brain, and then falls back down to the heart again. Although gravity opposes the upward flow, it assists the downward flow and so, overall, has no effect on the resistance to blood flow. The only resistance is the frictional resistance of the blood vessels.

If that is the case, why does the giraffe maintain such a high blood pressure? Badeer suggests that high pressure prevents the blood vessels in the head collapsing as a result of the low gravitational or hydrostatic pressure so far above the heart. But, when the animal lowers its head to drink, the blood pressure in the head rises from the normal 150/100 millimetres of mercury (mmHg) to 350/250 mmHg as the animal stoops. Such a large increase in pressure ought to cause the giraffe problems. Badeer suggests that the cerebral circulation might be protected from the sudden increases in pressure by a corresponding increase in the pressure of the cerebrospinal fluid, so that the difference in pressure across the walls of the cerebral vessels remains the same whatever posture the giraffe adopts. As a further adaptation, the jugular vein has a series of valves which stop blood from flowing backwards to the lowered head.

When the giraffe stands upright, the circulation in the lower limb is under high pressure, even though the cerebral circulation is under low pressure. This extra pressure, added to the pressure of the heart pumping against the resistance of the blood vessels, tends to cause fluid from the plasma to filter out of the blood vessels into the tissues, causing oedema.

As long ago as 1929, physiologists suggested that the giraffe's plasma might contain a high concentration of proteins. This would increase the osmotic pressure of the blood so that it tends to draw fluids inwards and so counteract the loss of fluid forced out by hydrostatic pressure. This remains a possibility, though no one has tested the hypothesis. To withstand the high pressure in the limbs, limb arteries have very thick walls with a very narrow bore. In contrast, the arteries of the neck have thinner walls and a wider lumen, related, presumably, to the lower hydrostatic pressure of blood in the neck.

Climbing snakes, too, show modifications to counter the effects gravity has on their flow of blood. Harvey B. Lillywhite of the University of Florida has investigated the blood distribution and pressure of a number of species of snakes tilted head-up from the horizontal to the vertical (*Physiological Zoology*, vol 58, p 259).

He found that, in general, blood tended to pool in the tails of tilted snakes; blood pressure in the head fell correspondingly. The shift in blood volume increased with the angle of tilt. As the tilt increased, more blood moved into expanded blood vessels and plasma filtered out into the tissues under the influence of gravity. Seventy to eighty per cent of the total fluid shift was rapid and reversible, which indicates pooling of blood in stretched vessels. The remainder of the fluid in the tail is probably plasma filtered from the blood.

The gopher snake, *Pituophis melanoleucus*, is an active climber. Lillywhite found that it is much less prone to pooling and oedema than a ground-living rattlesnake, *Crotalus viridis*. Blood pressure in the "head-up" rattlesnake fell by 69 per cent; in the head-up gopher snake it dropped only 25 per cent. The arboreal gopher snake, like the giraffe, evidently has mechanisms to reduce blood pooling and oedema. Like the giraffe, the arboreal snake has a high blood pressure. The blood pressure at the head end of snakes in a horizontal posture was greater in the gopher snake (47 mmHg) than in the rattlesnake (30 mmHg).

Lillywhite suggests that the tree snake's high blood pressure might be the result of the way its blood vessels are adapted to reduce gravitational pooling and oedema; thick-walled, narrow-bore vessels, similar to the limb arteries of the giraffe, would offer a higher resistance to the flow of blood. Tree snakes also tend to have slender bodies and firm skins, analogous, Lillywhite suggests, to the slim, firm legs of the giraffe. □

Prehistoric Zaire

THE standard map of East Africa showing the important fossil and archaeological sites of early humans will now have to be extended a long way westward to take in some promising new sites along the Semliki River in Zaire. Members of an American expedition have just announced that the 300 simple quartz tools which they found last summer at a site called Senga, on the east bank of the Semliki River, could be 2 to 2·5 million years old. Only in Ethiopia, at the eastern Rift Valley sites of Omo and Hadar, have human artefacts this old been found previously.

The expedition's organisers, Noel Boaz of the Virginia Museum of Natural History, Jack Harris of the University of Wisconsin at Milwaukee and Alison S. Brooks of George Washington University, cannot yet be certain of the dating of Senga, but the fossil animal bones they found with the stone tools point to an age greater than 2 million years. The faunal evidence and studies of the sediments suggest that the site was then on the fringe of open country although it is now close to a lake.

Here, as elsewhere in Africa, between 2 and 2·5 million years ago, the climate became drier and the vegetation more savannah-like. Boaz, Harris and Brooks plan to study the palaeoenvironmental aspects of the site in greater detail on return visits to Semliki. They hope, too, that they might find traces of the makers of the first stone tools. □

Dentists at risk

DENTISTS and dental nurses run more than twice the risk of contracting certain types of brain tumours than those outside their profession, according to a team of Swedish doctors (*British Medical Journal*, vol 292, p 662). Anders Ahlbom and his colleagues at the National Institute of Environmental Medicine, Stockholm, looked at the records of more than 9000 dentists and nurses covering the 18 years since 1961.

Their results show that dental staff run an 80 per cent increased risk of glioma and 110 per cent increased risk of glioblastoma compared with the rest of the population. The researchers broke down the sample by sex and professional status. They found that the increased risk was the same in all groups.

The problem with surveys of this type is that the normal incidence of tumours is so low. Normally, one would expect one glioma or glioblastoma to arise in a population of 1000—hence the need for so large a sample. Ahlbom and his team found 22 tumours in their 9000 subjects, a figure significantly above the norm. The team concludes that the most likely cause is an occupational factor such as amalgam, chloroform or radiotherapy. □

Exercise lengthens life

EXERCISE helps to protect men against death by any cause, if Harvard alumni are anything to go by. Ralph Paffenbarger of Stanford University finds that exercise added extra years to the lives of some of the 17 000 Harvard graduates who answered a questionnaire about health and life style in 1962 and 1966 (*New England Journal of Medicine*, vol 314, p 605).

An earlier study of the alumni showed that those men who expended 2000 kilocalories (calories) a week in walking, climbing stairs or playing sports were much less likely to have heart attacks. Paffenbarger has now shown that men who exercise to this modest level also have a 29 per cent lower rate of death from all causes than do less active men.

Rates of death from all causes declined steadily as energy expended in exercise increased from 500 to 3500 kilocalories per week. Men who expended 3500 kilocalories a week in exercise died at half the rate of the least active men, in all age groups. By the age of 80, those who exercised had gained an extra year or two of life. □

Geospace and the polar platform

Michael Rycroft

DESPITE the devastating loss of the space shuttle Challenger in January, researchers in Britain and around the world continue to make plans for space programmes involving the shuttle.

Two years ago, President Reagan called on scientists from other nations to participate in the next ambitious American venture in space—the Space Station programme. The programme proposes to put a manned space station, with one or more co-orbiting platforms, in an orbit at an altitude of up to 500 kilometres.

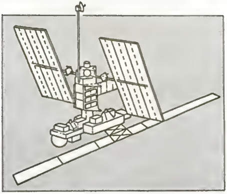
Another major element of the programme is an unmanned "polar platform", which will orbit the Earth at an altitude of more than 800 kilometres and reach latitudes greater than 80° North and South. The European Space Agency (ESA) has responded to the American call with a programme called "Columbus". Britain's part in the Columbus programme concerns the platforms.

Last month, a group of scientists met at the Scott Polar Research Institute in Cambridge to discuss the unique scientific opportunities afforded by the polar platform. The platform can carry an enormous mass of instruments, up to 2 tonnes, into polar orbit. It will be launched from Vandenburg Air Force Base in California aboard a space shuttle carrying a total payload of about 11 tonnes. The volume available for the payload, which has to fit inside the shuttle's cargo bay, is also large—18 metres long and 4·6 metres in diameter. Furthermore, the polar platform can transmit data from the instruments back to Earth very rapidly—at 300 megabits per second.

A platform is just an orbiting "laboratory bench" on which to set up experiments using the latest instruments. Downward-looking instruments for remote sensing are invaluable in studies of oceanography, hydrology, geology, geophysics, ecology, meteorology and atmospheric science. Other instruments can view outwards, to study the Sun and other astronomical objects. Another set of instruments might investigate the plasma environment around the polar platform.

In the field of solar-terrestrial physics, the platform provides splendid opportunities to study the Sun, the Earth's upper atmosphere, the ionosphere and the magnetosphere (the region of the Earth's magnetic field), and basic plasma physics with excellent temporal and spatial resolution.

One of the scientists' priorities will be to measure the "solar constant", the Sun's output of energy (which drives the Earth's weather systems) and its variability. The intensity of solar ultraviolet radiation determines the temperature structure and also the distribution of minor constituents in the stratosphere and above, such as ozone and nitric oxide. The flux of solar X-ray and extreme ultraviolet radiation determines the height distribution of thermal plasma (a gas of charged particles formed of negative electrons and positive ions) in the ionosphere at low and middle latitudes (0°-60° North and South). At high latitudes, above 60° North and South, auroral electrons bombard the uppermost atmosphere and cause additional ionisation there. All these "geospace" phenomena require further study and provide the impetus for research in solar-terrestrial physics.



The polar platform

The solar wind is ejected supersonically from the Sun's outermost atmosphere, the solar corona. High-speed streams of solar wind buffet the magnetosphere, causing geomagnetic storms and moving the auroral zones to lower latitudes ("A view of the upper atmosphere from Antarctica", 28 November 1985, p 44). A large portion of the auroral oval could be "photographed" in different parts of the electromagnetic spectrum from the polar platform. Most of the energy associated with such geospace processes is finally deposited in the atmosphere at heights above 80 kilometres over the polar regions. The polar platform will be well placed to study this process.

With sensors on ejectable sub-satellites in addition to instruments on long booms attached to the main platform, it would be possible to measure the fluxes of energetic electrons and different ions in the radiation belts along the orbit as well as electric and magnetic fields and waves.

Another of the programme's aims is to study the plasma environment near the platform. This should reveal something about wake phenomena and electric charging of the spacecraft, particularly when the thrusters are fired to alter the orientation of the platform.

Several different types of experiments in plasma physics are possible, too. These could involve the injection of neutral gas, energetic electrons or ions, to disturb the plasma around the platform. It might also be possible to transmit radio waves at frequencies ranging from a few kilohertz, to generate whistler-mode signals, to tens of megahertz. These would stimulate natural resonances within the plasma and enable scientists to determine some parameters of the plasma. The polar platform will at last provide adequate facilities for the large instruments needed to advance solar-terrestrial physics, and also for remote scanning in the polar regions. □

Do bones stop growing at zero gravity?

SCIENTIFIC experiments aboard orbiting space shuttles are showing that space flight has several overt effects on the human body. Now there is growing concern that prolonged weightlessness might affect human physiology in more profound, and possibly irreversible ways. NASA is stepping up its programme of research to discover more about how the body behaves under conditions of zero gravity.

The first indications that weightlessness might not be good for an astronaut's health came to light 10 years ago, when the team that spent three months aboard Skylab began to lose calcium from their bones. Bone is not an inert material, but is continually broken down and remodelled, a process controlled by hormones. Researchers studied immobilised or paralysed patients whose limbs, like those of astronauts, are relieved of their normal weight-bearing function. They measured the uptake and distribution of a radioisotope of calcium in the skeleton and were able to show that in the immobilised patients, the osteoblasts—cells that form the matrix in which the bone minerals are laid down—stop forming bone.

In a new study funded by NASA, Daniel Bikle, of the University of California at San Francisco, and his colleagues attempted to reproduce the effects of weightlessness in growing rats by suspending them by their tails for long periods, so taking the weight off their hind limbs (*Endocrinology*, vol 118, p 733). This approach allowed them to compare the growth of the load-bearing and the resting parts of the skeleton, eliminating effects caused by changes in the levels of hormones in the blood, which would affect the whole body.

The researchers found that if rats stayed in this position for a month, only the bones of the unloaded hind limbs stopped growing. But this response to having the weight taken off their feet lasted only a short while. After a few days, the long bones of the rear legs began to gain weight and accumulate calcium. Separate measurements of osteoblast activity and calcium accumulation showed that the rate of mineralisation in the bones of the hind legs was slow to catch up, but the rate of production of matrix material returned to normal in two weeks. Most probably, the changes in the mechanical stimuli act as a signal to switch on or off the processes of bone formation in individual bones.

The NASA study shows the body's remarkable ability to adapt to conditions quite alien to normal experience. The results suggest that people could make long flights in space without elaborate arrangements for creating artificial gravity. □

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TECHNOLOGY

Radiopaging around the world

John Lamb

BRITAIN'S Royal Signals and Radar Establishment (RSRE) wants to give international truck operators a helping hand. The establishment plans to set up an experimental satellite paging system which would enable British lorry owners to send messages of 300 characters to drivers anywhere in Europe, North Africa and the Middle East.

The messages would be beamed up from Britain to a satellite owned by Inmarsat in geostationary orbit, and broadcast to vehicles equipped with small antennae the size of the flashing blue light on a police car. Each antenna will cost about £500.

Decoding equipment in each lorry's cab would respond to signals containing its call sign and display the message to the driver on a light-emitting diode display.

The RSRE, with the backing of the British National Space Centre, has sent out notices to six British companies inviting them to bid for the first phase of the scheme. To begin with, the RSRE plans to commission a feasibility study and then to build 10 prototypes that will be lent to truck operators so that they can test the idea.

"At the moment truck companies have difficulty keeping in touch with their people. Getting them to 'phone home is not as easy as it seems," says John Everett, head of the civil programme at the RSRE's site at Defford, in Worcestershire.

Everett reckons that truck operators would be able to compose their messages on a terminal and forward them to a central collecting point for automatic transmission to the satellite.

Drivers, however, would not be able to respond to their instructions. Everett says two-way transmission would fall foul of many country's broadcasting regulations, and in any case would be "politically unacceptable".

The RSRE will have to be sure that messages actually get through to trucks. The vehicles will be out of contact with satellite signals for some of the time, when they are in tunnels or under bridges for example.

Messages will be sent half-a-dozen times each hour to ensure that they get through. During the system's development, decoders will log the number of times that they receive a message to give researchers an idea of how good reception is.

The paging scheme, similar in concept to existing radiopaging services, will operate on the 1·6-megahertz L-Band, with British Telecom probably supplying the Earth station for the "up-link".

● Passengers on ships will soon be able to watch satellite television. The council of Inmarsat, which runs maritime communications satellites, last week approved a trial service, which will last for a year.

The service takes advantage of the ability of satellite channels to carry data at high rates with few errors. Also, new ways of compressing video signals greatly reduce the amount of data needed to transmit a colour television picture.

Earlier this year, the US's satellite organisation COMSAT conducted a trial of television on the Queen Elizabeth 2. It now intends to provide eight hours of transmissions a day of compressed video signals, transmitted at 768 kilobits per second. □

New tool boxes for agricultural research

FARMERS in Britain can look forward to an unprecedented range of advances in agricultural technology. The government's Agricultural and Food Research Council (AFRC) last week outlined some in its corporate plan for the next five years. The council says its scientists "have a greater variety of exceedingly powerful research techniques than they have ever had". Its problem is developing them as the government's spending on agricultural research declines.

Biotechnology offers many prospects for agricultural research. For example scientists at the universities of Durham and Warwick, working with the John Innes Institute and the Plant Breeding Institute near Cambridge, are working on a "plant gene tool-kit".

Genetic engineers have made progress in transferring genes between plants, much remains to be learnt. The tool kit will enable breeders to identify and isolate particular genes in plants. Of particular interest are those that control desirable characteristics such as resistance to diseases and, growth at low temperatures and in dry soils.

Conventional methods of breeding—the classic approach of selecting for the right qualities—are slow and often do not work. The "gene tool-kit" should allow researchers to insert any gene into particular crops.

The first stage is to identify organisms that can carry strands of foreign DNA into plants. The most commonly used is a bacterium called *Agrobacterium tumefaciens.* It is easy to engineer, but does not infect many plants. The British programme is looking for vectors that will carry genes into wheat, barley, rape and pea.

Another part of the tool kit will be techniques of inserting desired genes into protoplasts (cells with their cell walls removed). Some plants, such as petunias, are relatively easy to grow from protoplasts. But important agricultural plants, especially cereals, are not. Much of the work will involve formulating standard conditions for regenerating crops.

Probably more exciting to the farmer, the research council plans to step up its work on agricultural robots. According to the corporate plan, robots will soon be milking cows, as well as carrying out repetitive tasks such as pruning trees, harvesting and picking.

Robots will also find work in the slaughterhouse, grading, cleaning, jointing and processing meat. Swedish researchers have already developed a robot butcher.

"As high-technology computer-based products and solid-state cameras become more complex, capable and at the same time cheaper, their incorporation into robots for agriculture and food will lead to efficiency and cheap processes for the industry, relieving people of the more tedious jobs they are required to do at present," the plan says.

The same technology would also find applications in food processing. Automatic processes would need equipment to measure the flow of particles, and assess the texture of food products.

However, developing these sensors will need more money, the plan says. Researchers need funds to look at light-emitting diodes, fibre optics, sensors with telemetry for controlling mobile machines and machine vision.

The immediate problem is money. The research council's secretary, John Jinks, says in the plan's foreword that he does not yet know how much money he will have to spend next year. "The council . . . stresses the need for adequate future budgets and for some measure of stability and consolidation," he says. "Without this, the effectiveness of the policies expressed in the corporate plan will be seriously diminished." □

How to survive a dogfight blackout

PILOTS are the weakest link in today's agile fighter aircraft. Planes can manoeuvre faster and more tightly than ever before—but pilots black out before the airframe reaches its limits.

In principle, air combat has not changed much since the days of the Red Baron. "Whoever can turn faster has more chance of winning," says Jean Coreau of the French aerospace firm Dassault-Breguet. Dassault has redesigned the cockpit of its new agile fighter, the Rafale, and invented new suits for pilots to stop them blacking out during these manoeuvres.

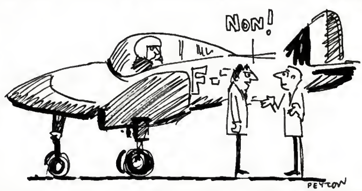
Rafale's tight and fast turns will subject the pilot to accelerations of nine times the force of gravity (9 g).

Such forces pin the pilot's head and arms in place. Blood vessels dilate automatically to relieve the pressure. If the pilot is sitting upright, the net force during a turn will be towards the feet. Blood flows from the head into the dilated vessels, without warning if the turn is fast enough. Pilots can black out for 20 seconds before the aircraft, left to itself, comes onto a more comfortable course—or crashes.

In spacecraft, reclined seats put astronauts at right angles to the forces. But fighter pilots cannot lie on their back; they need to reach the controls and to see where they are going. Most fighter seats recline by 15-20°, the American F16's by 29°. The pilot of the Rafale will lie at an angle of between 32° and 37°. In this position, the pilot can no longer see a conventional control panel. Dassault has moved all the Rafale's controls and instruments into a small panel between the pilot's knees, and to a "head-up" display on the windscreen. The control sticks are operated with on elevated armrests, which Dassault hopes will prevent the small haemorrhages just below the skin which can appear on the hands and arms of jet pilots.

During tight turns, however, only the pilot's fingers will be moveable. Dassault has put most of the firing controls into the stick, while many of the rest, says Coureau, will be voice controls. The problem: high g forces distort the human thorax enough to change the way voices sound to machines.

Rafale's computer will calculate when a pilot is about to be subjected to high g forces, and command an "intelligent" suit to inflate around the lower body. The suit squeezes harder just as the plane goes into a turn, keeping blood in the pilot's head. Today's fighters are built to be unstable—only computers can keep them and their pilots on course. ☐



Discord over plans for better television pictures

THE FRENCH government is campaigning against Japan's proposals to set a world standard on high-definition television. Broadcasters everywhere want to achieve better television pictures. The argument is about how they can do it.

Japan's proposal is that television studios should record images on video tape in high definition (1125 lines per frame) at a rate of 60 pictures per second. This would replace the technique of recording images on film. Japan does not have a substantial film industry, so it is keen to push video at the same time as high-definition television.

The French authorities call Japan's proposal "inequitable, premature, unfair and unsuitable for Europe". The French want to adopt a system that British engineers developed at the Independent Broadcasting Authority's laboratories near Winchester.

So far, the British government has made no move. British broadcasters and electronics firms are worried, because an international body, the Consultative Committee on Radio Communications, will set the standard in May.

The technology at the heart of the dispute is complicated. But there is one key factor. This is the difficulty (some engineers say impossibility) of converting programmes made at a rate of 60 pictures a second into the signals of 50 hertz broadcast throughout Europe.

Engineers around the world agree that the existing standards of television need improving. The Japanese broadcasting company NHK has developed a high-definition system which relies on 60 pictures a second, with each full picture made up of 1125 lines. Programmes made in this format can easily be downgraded to the 525-line standard broadcast in both Japan and the US.

The Japanese government supports NHK's proposal. So does the US government. For the past two years, CBS in the US has been lobbying for the adoption of the same system in North America.

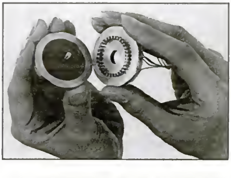
European and Australian broadcasters want to transmit programmes in future with the British technology, called MAC (multiplexed analogue components). MAC improves the picture's quality while relying on 625 lines, renewed 50 times a second.

Television studios usually make programmes first onto film, for the highest possible quality of pictures. The Japanese-American lobby wants studios to stop using film, and instead record programmes directly onto video tape in the 1125-line, 60-frame standard. This will be fine for Japan and the US, which can easily convert the video recording to their broadcast standards of 525 lines, with 60 frames a second. But pictures will look jerky and smeared if converted to the European standard.

European electronics companies such as Thomson and Philips want to wait until a new all-digital system is ready. In such a technology, the picture rate becomes irrelevant. The French government dislikes the idea of forcing its broadcasters to buy more equipment from outside the European community. The British government, which started the whole ball rolling by recommending MAC technology for satellite broadcasting, seems to have lost interest in the whole debate.

Bryce McCrirrick, director of engineering at the BBC, said: "We think Europe should wait until a recording system is ready which gives enough headroom." ☐

High-pitched drive



ULTRASOUND rather than magnetism is the driving force in a new type of motor that the Japanese company Matsushita has developed. The advantage is that the motor will run smoothly at low speeds without the need for gears.

Matsushita, the largest maker of consumer electronics in the world, built its fortune on electric motors. But electromagnetic motors do not perform well at low speed, and need a train of gears to produce slow movements smoothly.

The ultrasound motor consists of a fixed plate or stator carrying a ring of piezoelectric transducers, which act as tiny loudspeakers. These generate waves of ultrasound which vibrate a ring of friction pads. The pads bear on another ring which is free to turn on a spindle.

The high-frequency signal that drives the transducers causes the soundwaves to move around the stator, pushing the rotating ring around. Matsushita says the motors will find applications in robots and cars.

The motor may not be suitable for the home. It runs on sound with frequencies ranging from 28 kilohertz to 72 kilohertz. Humans cannot hear noise pitched this high, but dogs can. High levels of ultrasound can cause them discomfort, and even damage their ears. ☐

Europe joins the race for superchips

Peter Spinks, Amsterdam

POLITICIANS wrangle over Europe's future in microelectronics, while researchers in Holland and West Germany master the industry's building blocks.

Philips in the Netherlands and Siemens in Germany are spending £400 million to learn how to work with components less than 1 micrometre across. The aim is to catch up with Japanese companies in building very powerful microprocessors. The researchers say they will have a dynamic random-access memory capable of handling four million bits of information by 1987.

The venture, called the Megaproject, is developing optical equipment accurate enough to implant details as small as 0·7 micrometres across on silicon chips. Fine structures mean faster components, which are essential to very large-scale integration. The goal is to cut the switching delay of transistors to 90 picoseconds. Until now, such speeds have remained in the domain of bipolar transistors, which can handle only tiny currents.

To develop the technology for working at these sizes, Philips is working with an optical system operating at the emission line of mercury light (356 nanometres). The lens is incorporated in a wafer stepper, which reproduces patterns of integrated circuits to be reproduced repeatedly on a wafer of silicon.

The idea is to project the reduced image of a mask (the glass plate that carries the original image of the circuit) through the lens onto part of a silicon wafer. A photosensitive chemical covers the surface of the wafer. Following processing, another layer of photoresist "fixes" the circuit's pattern.

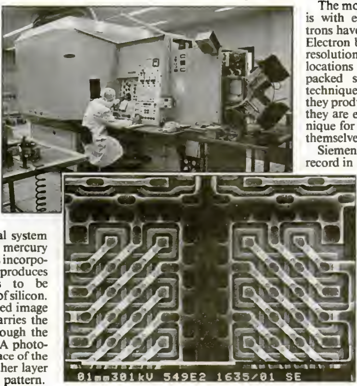
The wafer then shifts away, and projects the pattern again. When the wafer is covered with these identical patterns, it is cut up into separate chips.

Lithography with X-rays can define structures smaller than a micrometre. This process requires very precise positioning; the mask and chip must be in the right position to within a few hundredths of a micrometre. The only way is with a piezoelectric drive—crystals of quartz that move by minute amounts in response to a voltage across them.

The researchers are still struggling to overcome obstacles in the race for smaller and more complex chips. One is the difficulty of isolating transistors from one another. The 1-micrometre structures on a 1-megabit memory conduct 5 volts, which is enough to generate a powerful electrical field between separate transistors. The phenomenon can endanger a circuit's stability. The way round is to apply a thin layer of metal over the wafer's surface.

Static memories with capacities of 1 megabit contain more than five million transistors. Only a computer can design and test them. Siemens has developed a computer-aided design system called Venus. It stores a library of standard cells which act as building blocks for a circuit. It translates the logic diagram into a layout for a circuit which serves as the basic model for developing the required chip. The technology cuts the time taken to design an integrated circuit containing more than 5000 logic gates from months to a few weeks.

Simulation techniques allow engineers to predict the ways in which the atoms of a transistor will be distributed when all the stages of manufacturing are complete. These profiles determine the components' electrical characteristics; they can also simulate the behaviour of individual components. This information enables designers to compute the electrical characteristics of transistors, such as the field strength and current patterns. If the designers know what is going on inside a transistor, they can make it smaller.



Catching up with Japan—equipment and product of the European chip industry's Megaproject

Computers will test chips coming off the Mega production line by identifying unsound chips and defective areas in them. They collect information to establish whether certain areas on the pattern regularly produce parts that fail.

It is possible to repair memory chips: a laser hooks up extra memory cells, and burns off the defective ones. The process requires great precision, but it takes only a few seconds for each chip.

The most precise way to define a pattern is with electron-beam lithography. Electrons have a shorter wavelength than light. Electron beams produce lines of very high resolution and these lines pinpoint the locations of transitors in very densely packed semiconductors. Electron beam techniques are relatively quick, as long as they produce small numbers of circuits, but they are expensive. Siemens uses the technique for masks, but not for making chips themselves.

Siemens has an undistinguished track record in mainframe computers, but it was the first European company to sell a chip with a memory of 256 kilobits. To ensure that its 1-megabit dynamic random-access memory is on time, the company has agreed to share production technology with Toshiba of Japan. "This became necessary since international competition has become more intense and the development times, particularly in Japan, have shortened," says Kurt Garbrecht, head of Siemens's integrated circuits division in Munich.

The company's plans for a 4-megabit memory now depend largely on how far the Europeans can push back the frontiers of submicrometre technology. Judging by the present rate of progress, designers will not reach the physical limits of miniaturisation until 2020, when memory chips capable of handling 16 or even 64 megabits may be commonplace. □

Duplication at the speed of light

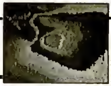
VIDEO DISCS continue to find applications in industry. The latest is to duplicate cassette tapes at high speed. The record company Capitol developed such a system for mass-producing music tapes, but it also works for tapes that carry computer programs.

Recording plants normally duplicate tapes by recording them in banks at 32 or even 64 times normal speed. The material to be recorded comes off a loop of master tape, also running at this speed. This means the loop runs at up to 1200 centimetres per second, so is easily damaged and quickly wears out.

Capitol, a North American record company owned by Thorn EMI, has replaced the tape with an optical disc. The disc is of the WORM (write once, read many times) type. A powerful laser in the recorder burns a patter on digital pits into a tellurium coating on the disc's surface.

When duplicating cassettes, the disc runs at 32 times the normal speed. So the digital code streams off the disc at a rate of about 64 megabits per second. This signal goes through a digital-to-analogue converter, and still at 32 times normal speed, to a bank of slave machines. The result is a conventional analogue cassette.

The laser-read master disc should last forever. Capitol plans to start selling optically duplicated cassettes this summer. The firm is already experimenting with a WORM drive that runs at 64 times normal speed. Engineers believe they can modify the technique to speed up the copying of digital data from a computer onto a magnetic disc. □



Jerry Mason

Europe captures the comet

Last Thursday, Europe achieved a space triumph. The spacecraft Giotto flew within a few hundred kilometres of the nucleus of Halley's comet and survived. Scientists are now unravelling the mounds of data that the craft transmitted to Earth

Helen Gavaghan, Darmstadt

Max-Planck Institut

Jerry Mason

Halley's Comet photographed by Kurt Birkle with the Schmidt telescope in Spain (above). The day of encounter dawns in the European Space Operations Centre (left)

JUST BEFORE midnight last Thursday night, a quiet voice announced over the tannoy to scientists in the European Space Operations Centre that Giotto should now be making its closest approach to the nucleus of Halley's Comet. But Giotto was 150 million kilometres from Earth, and its signals took nine minutes to reach the centre in Darmstadt, West Germany. During those nine minutes, scientists gathered around their visual display units waiting for an answer to the question uppermost in everyone's mind—would Giotto survive the storm of dust it was passing through?

Until two seconds before the closest approach, the data kept coming. Then the same quiet voice said: "We have lost telemetry." Scientists stood still and apparently calmly while they waited for the voice to speak again. A few seconds later it said: "We are receiving intermittent signals."

Giotto had survived, and although dust had battered the craft so that its antenna was swinging into and out of alignment with the Earth, the dampers on board would soon deal with that problem. Throughout ESOC, the search for champagne glasses began.

Even without the re-established link with Giotto, scientists were well satisfied with the mission and the mounds of data that Giotto relayed to Earth. Shortly after the encounter, professor Tony McDonnell, from the University of Kent, compared the 150 dust impacts recorded on the bumper shield by his group in the last second to firing a shotgun.

Two of Giotto's experiments were led by British Scientists. McDonnell's group ran the dust impact detection system (DIDS) and Alan Johnstone's from Mullard Space Science Laboratory, ran one of the plasma experiments (JPA). DIDS and JPA were among the experiments to collect data about the very beginning and end of Giotto's encounter with the comet. Buried in the DIDS data is information about the dust particle that played the cosmic vandal and knocked Giotto out of contact with the Earth. And members of the JPA group believe that theirs was one of the first experiments to pick up the effects of the comet on the spacecraft's environment when they detected hydrogen ions eight million kilometres from the nucleus (see pages 37 and 40).

DIDS and JPA are two of 10 experiments that Giotto carried to Halley's comet (see table). The European Space Agency (ESA) intended that Giotto would carry these experiments, including the camera built by the Max Planck Institut, to within 500 kilometres of the nucleus.

The encounter distance of 500 kilometres was a compromise between the needs of different experimental groups. The camera, for example, would not work because of dust particles if it got closer than 500 kilometres to the nucleus. The dust experimenters, on the other hand, wanted to get close to the nucleus where the distribution of the dust gives information about the topography of the nucleus. The reason was that the jets of dust particles become more diffuse the further they travel from the nucleus.

Such a near encounter was possible only because of an agreement with Intercosmos—the Soviet space agency. Spacecraft from the Soviet Union, Vega 1 and 2, flew past Halley's Comet a few days before Giotto and recorded the comet's position. Intercosmos passed this information to ESOC's navigators.

Armed with this data and dust measurements taken by Vega, the experiment leaders and Gerhard Schwehm, the mission scientist, met on the Tuesday before the encounter to decide what fly-by distance the mission controllers should aim for. An important part of Schwehm's job is to act as a link between scientists and mission controllers. The meeting compromised on a distance of 540 kilometres—close enough for the dust experiments but, given an error margin of 40 kilometres in the targeting, a safe distance for the camera. The

Experiment	Principal Investigator	Purpose of the experiment
1 Camera	H. U. Keller, Max Planck	To take pictures of the cometary nucleus up to a distance of 500 kilometres.
2 Neutral Mass Spectrometer	H. Krankowsky, Max Planck Institute, W. Germany	To measure the energy and chemical composition of neutral particles given off by the comet's nucleus.
3 Ion Mass Spectrometer	H. Balsiger, University of Bern, Switzerland	To measure the energy and chemical composition of positive ions given off by the cemetary nucleus.
4 Particle impact analyser	J. Kissel, Max Planck Institute, W. Germany	To measure the chemical composition of individual dust particles.
5 Dust impact Detector System	J. A. M. McDonnell, University of Kent, Britain	To measure the quantity of dust particles of different weights within the range 10^{-17} to 10^{-13} grams.
6 Johnstone plasma analyser	A. Johnstone, Mullard Space Science Lab	To measure the velocity distribution of positive ions near to Halley's comet in order to find out how the plasma tail is formed.
7 Reme plasma analyser	H. Reme, Centre d'Etude Spatiale, France	To measure the energy of the solar wind and electrons from the comet and to measure the energy and mass of positive ions from the comet.
8 Energetic particles	SMP. McKenna-Lawlor, St Patrick's College, Ireland	To measure the energy of protons, electrons and alpha particles during the approach to the comet's nucleus.
9 Magnetometer	F. M. Neubauer, Institute fur Geophysik und Meteorologie, W. Germany	To measure the interplanetary and cometary magnetic fields.
10 Optical Probe Experiment	A. C. Levasseur-Regourd, Service d'Aeronomie due CNRS, France	To measure the brightness of the coma at eight different wavelengths.
11 Radio Science Experiment	P. Edenhofer, Institut fur Hoch- und Hochsfrequenztechnic, W. Germany	This experiment did not have equipment on the spacecraft. The data came from doppler shifts in the transmissions to Earth. Its purpose was to measure cometary electron and mass fluence.

same night ESOC's navigators sent the commands that put Giotto on course for its encounter. Immediately afterwards mission controllers turned on the experiments designed to measure magnetic field lines and the presence of ions and electrons. These experiments should then have worked without interruption up to the encounter.

At about 2300 hours on Tuesday, however, mission controllers lost all contact with Giotto. The reason—a bulldozer had dug up a telephone cable in Australia. The cable forms part of the link between ESOC and the antennas that transmit and receive messages to and from Giotto. Although the antennas are in different parts of Australia, both the uplink and downlink signals travel through the same stretch of cable for a short distance, and the bulldozer damaged this stretch. Although mission controllers instantly switched their communications to NASA's deep-space network, data still did not reappear on the screens. The back-up computer linked to the deep-space network could not pass data to the computer that was feeding the scientists' visual display units. For half an hour ESOC's experts battled with the computers' electronic intransigence, then data reappeared on the screens. Except for the few seconds of changeover to the deep-space network, data were not lost, because everything that Giotto transmitted was recorded at the receiving stations.

Despite such occasional communications problems, including one during the encounter rehearsal, the Giotto mission ran comparatively smoothly through its final week. John Credland, ESOC's payload manager said: "Giotto is a beautiful spacecraft. During the eight-month cruise phase, there were only nine spacecraft anomalies, some spacecraft can have that many in a day."

Jerry Mason

Alan Johnstone (third from the left) celebrates with members of his team

One anomaly that worried ESA's technical experts occurred only a fortnight before the encounter. For no reason that anyone can see, the spacecraft switched itself completely to its back-up system. For example, the motor running the mechanism that keeps the antenna pointing towards Earth as the spacecraft spins, wound down, and the back-up motor started. The first indication that mission controllers had of a problem was when the signal was lost as the motor switched itself off. Engineers worked for two hours to identify the problem, then spent 12 hours putting Giotto back into its original configuration so that it would still have a back-up system if a fault developed during the encounter. "What really worried us," said Andrew Parkes, the flight operations manager, "was that we had no idea of the cause."

Fortunately, no faults developed while the experiments gathered data during the final part of the cruise to Halley's Comet, and everything worked smoothly during the four hours before the closest approach. At 1100 hours, acoustic sensors on the dust shield picked up the first dust particle. It weighed 10^{-10} grams—about the weight of a grain of cigarette smoke. As Giotto neared the nucleus, so many dust particles hit the detectors that scientists were unable to keep up with the measurements. So details of the dust that set Giotto spinning out of control are buried in the data that the DIDS group is now working on.

DIDS, however, started detecting particles weighing 30×10^{-6} grams two minutes before Giotto lost contact with the Earth. These particles hit the spacecraft with a speed about 50 times that of a bullet. They smashed through the thin aluminium bumper shield, which dissipated their energy slightly, before they encountered Giotto's secondary line of defence, a tough sheet of Kevlar—the material from which bullet-proof vests are made. But as the nucleus and Giotto approached one another at 68 kilometres/second, one of these dust particles hit the spacecraft with sufficient force to tilt it out of alignment with the Earth.

After about half an hour Giotto's dampers steadied the spacecraft, and most experimenters were receiving continuous data again. To the disappointment of the camera team, though, no more images were received showing the other side of the nucleus. The last photograph of the nucleus was taken from a distance of 3 500 kilometres. In the final sequence of pictures, including the last to be taken (at the top of the previous page), the camera is pointing at the jet.

By 0900 hours on Saturday morning, mission controllers were again sending commands through to Giotto. Now scientists are dismantling their equipment and beginning a detailed analysis of their results. ☐

Halley's Comet: more dirt than snow

Giotto's plunge into the comet has laid bare its darkest secrets. The scientific impact has surpassed astronomers' wildest expectations

Nigel Henbest

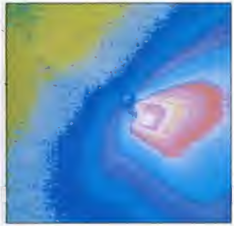


Figure 1. *A jet of gas and dust, appearing pink in this false-colour image from Giotto, stretches 100 kilometres to the right of the nucleus of Halley's Comet. The nucleus is the irregular blue and white "tadpole" in the centre of the frame*

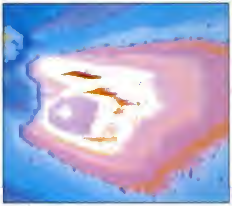


Figure 2. *The brightest part of the jet (yellow and pink here) dominates this closer view. The jet shoots away from the nucleus, upper left, extending out of the frame. The pale blue and yellow at the top left are brighter parts of the nucleus; the darker parts are shown dark blue. The mottling of the surface shows pits less than one kilometre across*

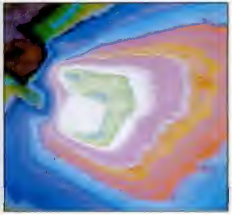


Figure 3. *As Giotto drew closer, its camera homed in on the bright jet. Astronomers had expected that the nucleus would be bright and had programmed the camera accordingly. Only a small portion of the nucleus appears here, as the dark shadow at the top left*

SIPA Press

GIOTTO'S observations confirm the broad outline of what astronomers had believed to be going on in a comet. In the centre, there is a small solid nucleus, which emits gas and dust. The gas molecules are broken down into radicals and ionised by the action of the Sun's ultraviolet radiation and by the impact of particles in the solar wind. There is a "bow shock" where the solar wind runs into the gases expanding out from the comet. But no-one had predicted the precise details. The Giotto project scientist, Rudiger Reinhard, remarked "there are a very large number of exciting and surprising results – more than expected".

A comparison of Giotto's observations with those from the two Soviet Vega probes shows that the output of gases from the comet's nucleus is changing extremely rapidly. The head of the Soviet team, Roald Sagdeev, said that the results have effectively shown us "three different comets".

Even outside the bow shock, Giotto began to pick up signs of the comet disturbing the solar wind. Eight million kilometres out, it picked up the first hydrogen ions from the comet. Four million kilometres from the comet's centre, Giotto went through a region of magnetic turbulence similar to a region that the International Cometary Explorer (ICE) had found much closer in to the centre of another comet: Giacobini-Zinner (see Box). Three hours later, there were more definite signs of the comet's escaping gases, as Giotto's plasma analysers picked up ions with an energy of 2 kiloelectronvolts (keV), twice that of particles in the solar wind. Giotto also found that the solar wind, which had been "blowing" steadily at a speed of 380 kilometres/second, was now being slowed to 350 km/s as it picked up the cometary particles.

But a much bigger change was in store ten hours later – just four hours from closest approach to the nucleus – when Giotto crossed the bow shock. In fact, the "shock" was not nearly as sharply defined as familiar examples on Earth, such as the sonic boom that precedes a supersonic plane. Giotto's scientists term it a "bow wave" instead. ICE had found a similarly broad bow wave in comet Giacobini-Zinner.

Giotto encountered the beginning of the bow wave 1.1 million kilometres out from the nucleus. This was twice as far out as the Vegas had found it, because the solar wind had been stronger at the time of the Vega encounters and so had confined the comet's gases more. In the bow wave, Giotto found an increase in the energy of the electrons and in the strength of the magnetic field of the solar wind. Some particles attained very high individual energies, up to 20 keV. Both plasma analysers on board Giotto showed the bow

► p40

The cometary fleet

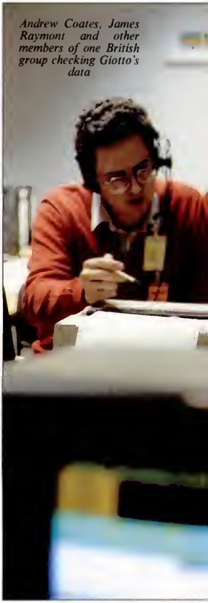
INFORMATION from other space probes that have passed Halley's Comet this month backs up Giotto's observations. Most important were the two Soviet Vega craft that passed less than 9000 kilometres from the comet's nucleus on 6 and 9 March, studying the dust and gases emitted.

The Japanese spacecraft Suisei passed by on 8 March, at a rather greater distance, taking pictures of the comet's extensive hydrogen cloud. Suisei's long-term surveillence has shown the hydrogen cloud "breathing" in and out, indicating that the nucleus is rotating, and only emits gases when one particularly active side is facing the Sun. The period of the "breathing" – and hence the comet's period of rotation – is about 53 hours.

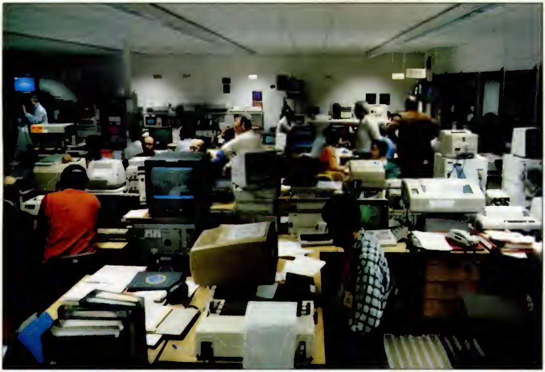
Two other spacecraft without cameras are also providing useful data. Suisei's sister-craft Sakigake passed through the outer part of the comet on 11 March, measuring conditions in the gas. The International Cometary Explorer (ICE) is between the comet and the Sun. It is monitoring the speed and activity of the solar wind, the stream of ions and electrons, with associated magnetic fields, that sweeps from the Sun out through the Solar System. Last September, ICE made the first measurements within a comet when it swept through the tail of comet Giacobini-Zinner, just 8000 km from the nucleus on the side away from the Sun (*New Scientist*, 28 November 1985, p 22). Its results make an interesting comparison with those from the Halley probes, which all pass on the comet's sunward side. □

Countdown to

Photographs by



Andrew Coates, James Raymont and other members of one British group checking Giotto's data



Encounter: engineers and scientists (top) monitor Giotto. John Credland, payload manager (above), during the rehearsal

Mission scientists: Gerhard Schwehm and Trevor Sanderson

Credland and the mission scientists concentrate as Giotto's last four experiments are turned on for the encounter

British scientists led two teams. Tony McDonnell (left), University of Kent, and Alan Johnstone, Mullard Space Science Laboratory

rendezvous

Jerry Mason

Mission control room during Monday's rehearsal: ESA officials control data to and from the ground stations and check that all equipment is working (top); Andrew Parkes, the flight operations manager (above), checks that everything is running smoothly. Felix Garcia-Castener (left), ESA's director of operations, looks in on the rehearsal

In control of one of the dust experiments: Tony McDonnell with John Firth who designed the electronics

Waiting for the first dust impact: members of McDonnell's team in the European Space Agency's science centre

Intercosmos

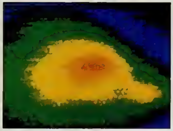


Figure 4. *Vega-1 saw the comet's elongated nucleus, but the surface was shrouded in dust. In this false-colour image, the brightest parts are red, and fainter regions orange, yellow, green and blue*

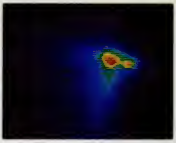


Figure 5. *As Vega-2 approached, it saw two bright jets (red in this image) emerging from the nucleus. This gave rise to false reports that the nucleus itself was double*

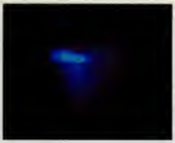


Figure 6. *This picture from Vega-2 clearly shows the "peanut" shape of the nucleus of Halley's Comet, because the bright jets are hidden behind the nucleus itself*

Hencoup Enterprises

Roald Sagdeev, the man in charge of the Soviet Union's Vega missions to Halley's Comet

p37 ▶ wave as a region 250 000 km thick where the speed of the solar wind slowed from 320 km/s to 260 km/s and its direction changed as it began to swerve around the comet. Giotto's instruments now began to pick up many atoms, molecules and radicals from the comet itself. These included positively-charged oxygen atoms, hydroxyl radicals, and carbon dioxide and water molecules. There were hints that the gases contained a suprisingly small amount of sodium, and possibly lacked sulphur too.

Astronomers had predicted a second, much more sharply-defined change, in the properties of the gas about 10 000 km from the nucleus. This region marks a transition from the largely ionised mixture of cometary and solar gases to the "atmosphere" of neutral gases that surrounds the nucleus. Just 65 seconds before its closest approach to the comet's nucleus, and 4300 km out, Giotto did indeed find a big increase in the number of neutral species. Its magnetometer also showed the expected drop in the field strength. The magnetic field of the solar wind is "tied into" the ionised gases. Oddly enough, one of the plasma analysers did register some ions in this region of supposedly neutral gas – but the ions may have been created by the impact of Giotto itself on dust particles.

The dust-detection team had expected that Giotto would run into dust about 500 000 km out, some two hours before its closest approach to the nucleus. The team based its calculation on theoretical models and on results from the two Vega craft, which had hit so much dust that instruments not protected by a bumper shield were seriously damaged. But Giotto suffered its first impact only 280 000 km from the nucleus. In the next half hour, Giotto received 14 more hits, one-tenth of the number expected. These were relatively small particles, less than a microgram in mass, which did not penetrate Giotto's bumper shield.

The first impact that penetrated the bumper – but not the thick second shield – came when Giotto was 8000 km from the nucleus. This 30-microgram particle was the first of a storm of larger dust particles. At least a hundred of them penetrated the bumper – and one of them was large enough to set Giotto wobbling, and so cause its signals to veer away from the Earth.

So the amount of dust was much less than predicted far out in the comet's coma, but higher than expected close in to the nucleus. Analysis of the spacecraft's radio signals confirmed this: the frequency was changed very slightly by the doppler effect as impacts with dust and gas slowed Giotto down. Giotto also found that Halley's Comet is producing surprisingly large amounts of very small dust grains, down to 10^{-17} gram.

The Vega probes had measured the composition of the dust in the comet, and had found at least two different types: some containing carbon compounds, and others a lot of iron. Giotto found a similar pattern, with 90 per cent of the dust grains consisting largely of carbon, oxygen and nitrogen, and simple compounds of these elements.

By far the most exciting result from Giotto was its observation of the nucleus of Halley's Comet. Giotto was in fact extremely lucky. When Vega-1 had passed by only a week earlier, the nucleus was hidden from view by its own dust. Vega-2 had a somewhat clearer view; but when it came to Giotto's turn, the nucleus was considerably less active, and it was exposed to view.

What Giotto saw (and is shown on our front cover), was a large black "potato", emitting two bright jets of gas and dust. The biggest surprise about the nucleus was its colour. As the leader of the camera team, Horst Keller, put it, "the nucleus is black, blacker than coal; as black as black velvet – its reflectivity is similar to the darkest material we know in the Solar System". Its reflectivity is around 1 or 2 per cent, rather than the 50 per cent or so that astronomers had been expecting for what they were calling a "dirty snowball".

Giotto's pictures show that the nucleus is 15 km long, but only 8 km or less in width. In shape, Keller compared it to a potato, peanut, or even a banana. The closest pictures show some structures on the surface. These ring-like depressions are probably not craters, but sealed vents or nozzles where the nucleus has erupted during previous orbits of the Sun.

The unexpected darkness of the nucleus, compared to the jets, explains some puzzling features of the Vega pictures. These showed two bright regions, each 3 km across, that some astronomers had interpreted as a double nucleus. It is now clear that these bright spots were in fact the two jets of gas and dust.

Giotto's camera was programmed to keep looking at the brightest region of the comet – which Keller's team had assumed would be part of the nucleus. But the camera instead homed in on the brighter jet. As Giotto moved in, the camera ended up seeing only this jet. The closest picture we have was taken from a range of 1480 km; but the last picture showing part of the nucleus was from 3500 km, taken 50 seconds before closest approach. This image, however, should reveal details as small as 70 m. An analysis of its last pictures shows that Giotto missed the nucleus by 605 km – within 70 km of the final target, as decided two days earlier – and passed it just four seconds later than predicted.

The black surface of Halley's Comet is almost certainly due to some kind of organic compound, and most astronomers would plump for a tar formed from simple organic molecules. But the discovery has come as strong ammunition for Sir Fred Hoyle and Chandra Wickramasinghe, who have long argued that comets contain substantial amounts of complex organic matter – including viruses. Twelve days before the encounter, they published a prediction that "the great majority of short-period comets must be astonishingly black, with reflectivities at their surfaces less than one per cent".

Because the nucleus is so dark, it must absorb a lot of the Sun's heat falling on it. If there were ice near the surface, it would evaporate away ten times faster than we observe. This leads Keller to conclude that there must be a very thick surface crust, that insulates the ices in the centre. He said "the dirty snowball is more dirt than snow". □

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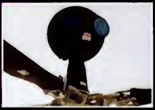

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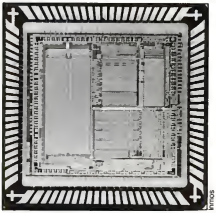
New chip displays its powers

The most powerful computer systems fill rooms. Could they become small enough to sit on a desk? One British chip manufacturer thinks so and has the prototypes to prove it

Nick Anning and David Hebditch

COMPUTERS no bigger than a suitcase, yet powerful enough to model a nuclear explosion or to plot Voyager's path to Neptune—not a dream, but something that is possible with existing technology. Indeed, prototypes for such machines exist. Based on a new type of microprocessor chip, known as a transputer, these prototypes cost a fraction of the price of a supercomputer. The transputer is the outcome of five years of development by Inmos, a company set up with money from the British government but now owned by Thorn-EMI. Inmos, based in Bristol, formally launched its T414 transputer in October.

Inmos has already confounded the sceptics who doubted that it could build, let alone manufacture in quantity, a microelectronic component to compete with those made in Japan and the United States. Inmos now makes several thousand transputers a week in its factory in Newport, Gwent. The yield of functioning chips has now reached some 60 per cent, no mean achievement in an industry that loses 10-20 per cent of far simpler products.



Inmos

For sale: transputers, only £350 each

The new chip is beginning to uphold its designers' claims about its power and performance. An early convert to the transputer is Smith Associates. The firm, a development engineering company with 50 employees based at Chobham in Surrey, worked with Inmos during the five years' gestation of the transputer. The engineers from Smith Associates used computer simulations of the T414 until they could get their hands on the first production prototypes. Chris Elliott, a director at Smith Associates, says that the ability of an array of transputers to process information in parallel—rather than a bit at a time—is "absolutely revolutionary". His company successfully bid for a contract from the Home Office to produce a prototype system for the police for recognising fingerprints gathered throughout Britain. The systems' transputers process data about the many variables on a fingerprint and match them in seconds against a central index. At least one foreign police force wants a similar system.

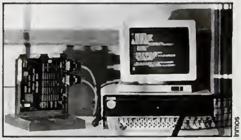
Inmos knows that it has a revolutionary development on its hands and that it has to work hard to persuade engineers to develop the skills needed to use its chips. To encourage the market for transputers, Inmos offers evaluation packages for people who want to try a transputer. These packages are standard circuit boards with one transputer and various

The transputer will become one of a family

INMOS intends the T414 transputer to be the first of a compatible range. Several factors underpin the importance of the T414: Inmos' philosophy of design, sophisticated manufacture and the variety of ways in which people can use the transputer.

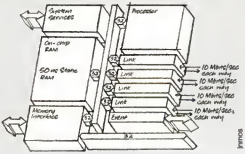
The T414 is a chip made by techniques of very large scale integration (VLSI). VLSI condenses the equivalent of 200 000 transistors into a space just under 9 millimetres square on the new microprocessor. The transputer is built up on several layers of aluminium and tungsten silicide using a technology called complementary metal oxide silicon (CMOS). Components made using CMOS demand less power, generate less heat and work faster than those made by other methods.

The dimensions of the transputer's circuitry and elements are as small as 1·5 micrometres. The transputer's job is to perform computations rapidly, so it has a central processing unit (CPU) that handles 32 bits of data at a time. The CPU is enhanced by 2 kilobytes of memory mounted alongside.



Inmos

An early product: a transputer board boosts a minicomputer's power



Inmos

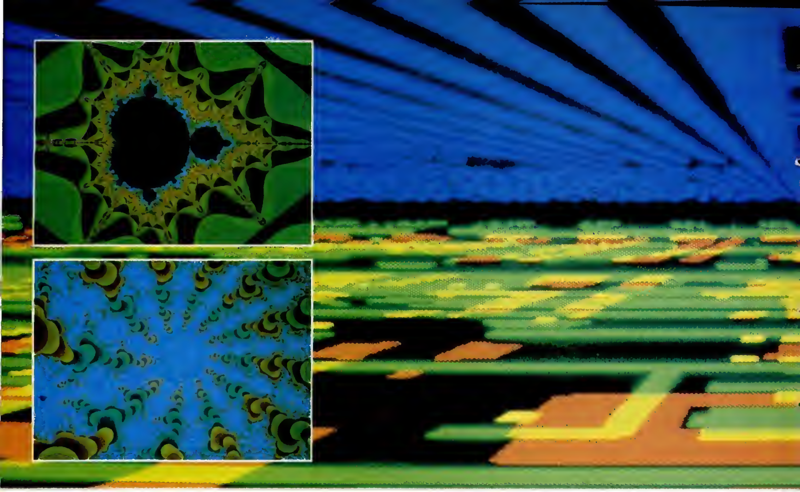
System services "manage" the T414. The event link synchronises the transputer with the rest of the computer

Most conventional computers, including supercomputers, operate by a series of sequential steps, imposing constraints on the potential of these machines. In a radical change to the design of chips the transputer is a parallel processor. It can carry out several computations simultaneously. The computer world uses the word "concurrency" to describe this feature. Concurrency gives the transputer an immediate advantage over most 32-bit processor chips, which take their instructions sequentially. Inmos' design team devised Occam, a completely new type of programming language, to manage the transputer's ability to process in parallel.

The microprocessor has four built-in communication links, working at 10 megabits a second, whose purpose is to link transputers together. A program written in Occam supervises the operation of a transputer by dividing tasks into "processes" and allocating their solution to specified parts of the CPU. But, and this is the decisive jump, Occam can also treat a complete transputer as a "process". The T414 is not merely a powerful component in its own right. Any number can link in different permutations to form arrays.

The most powerful T414 can process 10 million program instructions per second (MIPS), which makes it faster than other 32-bit microprocessors. So, as each transputer is added to an array, the array acquires a further 10 MIPS and increases the amount of information it can communicate by a potential 10 megabytes per second.

The links between transputers replace a databus, the mechanism in conventional computers to carry data between processors and memory stores. The databus, like a motorway, can only handle a certain volume of traffic before all its lanes become clogged. Transputers avoid this problem by communicating directly with each other and with the main memory. Each transputer has memory channels on which data flows at 25 megabytes a second, allowing it to communicate independently with up to 4 gigabytes of central memory. ☐



Transputers are good at graphics because they process data in minutes, other chips could take hours. A rapid change in the variables in the Mandlebrot Set (above and top), for example, requires a lot of computing power to display

Photographs Inmos and Meiko

memory chips. One board, the B002, can match the performance of a VAX 11/60 minicomputer made by Digital Equipment. Another, the B004, is for users of IBM's personal computers. The B004 costs about £3000 and has a purpose-built interface that allows it to run from the IBM's own operating system. One B004 increases the speed of the personal computer by a factor of 10. Inmos has sold more than 80 of these boards since last October. It plans shortly to issue a similar board for Digital Equipment's VAX system.

Inmos has gone much further than the single-transputer board. For its own use, the company has made a unit with 10 transputers. Inmos calls this package Item, for Inmos test and evaluation model. Researchers from Southampton University have already put Item to use. On the occasional weekends when Inmos was not busy with Item, researchers travelled from Southampton to Bristol to display models of crystals. The team from Southampton was keen to work with Item because it can process their data very quickly, saving the group hours of computing time on its VAX computer.

The transputer is well suited to processing the massive amounts of information involved in generating and manipulating images on a computer, a field known as computer graphics. Even a powerful computer can take hours to process graphic images, whether they are for TV broadcasts, film animation or computer-aided design. Transputers can produce complex computer graphics virtually as quickly as the operator can think, in "real time". Transputers work so fast because they treat each pixel—a picture element, the smallest component of the display—as a separate "process". Other machines deal with the whole display at once.

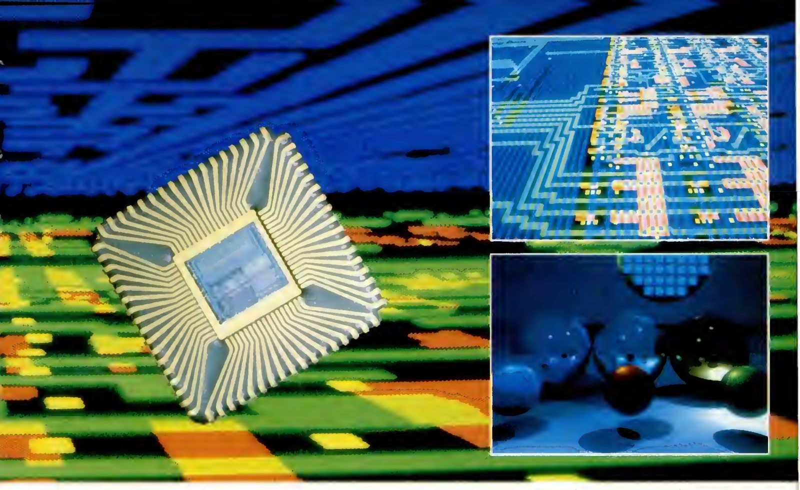
Phil Atkin, at Inmos, chose two tasks involving computer graphics to demonstrate the transputer's abilities; "ray tracing" and the so-called Mandelbrot Set. Both tasks require many repeated computational steps that take a notoriously long time: they are ideal tests for the new chip. Atkin has set up an array of 11 transputers to run these two tests.

Ray tracing is a modelling technique that builds up clear, realistic colour pictures from simple information. The computer receives a set of rules about light, shade, reflection and perspective. To give a standard example, the operator instructs the machine to construct a scene in which four-reflecting spheres, each a different colour, appear suspended above a chequered pattern. The computer assembles the picture line-by-line by calculating what happens to a single ray of light aimed from an imaginary point at each pixel in turn. Nine of the 11 transputers compute and allocate colours to each pixel. The picture comes up on the screen in, on average, less than a minute, though the time depends on the complexity of the scene depicted.

1200 million tasks a second

The Mandelbrot Set, described by one leading mathematician as "the most complicated object in mathematics", originates in the repeated manipulation of certain complex numbers. The computer plots the relationship between complex numbers on two axes of a grid of pixels on a screen. The computer allocates different colours to ranges of values, the interrelationship shows as a complex picture with a characteristic shape. The picture is infinitely complex; magnification of parts of it reveal greater and greater complexities. Atkin's array performs the repetitious calculations needed to produce this graphic representation of the Mandelbrot Set in a few minutes. Atkin would like to take on similar tasks, particularly a version of flight simulator, a popular computer game. Transputers are well suited to the rapid calculations required of a real flight simulator.

A machine called Computing Surface demonstrates the transputer's potential most dramatically. Meiko, a small company based in Bristol and closely associated with Inmos, designed and built Computing Surface, assembling the prototype in nine weeks. The prototype has 150 transputers work-



The chip that flies through itself. A program to simulate a transputer, when run on transputers (inset), creates a film-like look at the chip's circuits (background and top). A ray-traced picture (above) assembled line by line from simple data

ing in parallel, 128 for processing and the rest for displaying the results and management. As a demonstration, Computing Surface ran a graphics program derived from the data used to design and manufacture the T414 chip.

The demonstration began with a three-dimensional simulation of a transputer in four colours on the screen. The program then took a "real time" flight through the chip's structure. The latest Computing Surface has 150 transputers but, after testing by Meiko, it is twice as fast as the early version. It can handle 1200 million program instructions a second (MIPS) the sort of performance that only the biggest supercomputers can achieve. Yet Computing Surface, unlike a supercomputer, costs around £250 000, fits into a box the size of a microwave oven and requires little power.

David Alden and his colleague Miles Chesney at Meiko maintain that there is no limit to the number of transputers that can be connected together in an array, in theory. In practice, the power supply, earthing and the need to dissipate heat impose limits. At present they are content to design to a customer's specifications. "If a job needs 1000 transputers, says Chesney, "we'll link seven of our boxes together."

Meiko has already sold one of its machines in Europe. The Royal Signals and Radar Establishment at Malvern in Worcestershire is also interested in developing systems based on transputers. The RSRE, run by the Ministry of Defence, has long-standing research programmes on processing signals and voice recognition, both areas where arrays of transputers could prove more effective than conventional chips.

Computer programmers will not find it easy to use the power of the transputer. Alden says that engineers who want to use the chip need to think carefully about how they would apply a transputer system. It is not simply a matter of learning Occam, the chip's programming language, plugging some transputers into a system and hoping for an improvement. Occam is "superb", says Chris Elliott of Smith Associates, but he warns that programmers need to learn new skills to apply it. There is a danger with the language that it makes one or two transputers do all the work while the others try to catch up. "Everything that we have done with the transputer," says Elliott, "suggests that you can build a system which is 100 times better in terms of cost and performance than any conventional technology." He included under "conventional technology" supercomputers that perform faster than any standard computer.

In the mid-1970s, thanks to new designs of computers, the names Cray and Cyber became synonymous with supercomputers. Control Data Corporation (CDC) of Minneapolis built the Cyber 205: Seymour Cray, who left CDC to set up his own company, gave his name to the Cray computer. For several years Cyber and Cray had the field almost to themselves. Their machines seemed to be a sound if expensive investment for large oil companies, designers of aircraft, weather forecasters and the richest universities.

There are 12 Cray computers in Britain, 12 in France and eight in West Germany. There are more than 150 Cray and Cyber computers installed in the US. Large Japanese manufacturers, such as Fujitsu, NEC and Hitachi, have begun to challenge the American's lead in supercomputers. Conventional computers have also progressed in recent years with commercial minicomputers closing the gap between their performance and that of the slowest supercomputers. These minicomputers cost less than $1 million against the $10 million to $20 million for a Cray.

The kind of computing power possessed by a Cray is indispensable to physicists who want to simulate, for example, the collisions of elementary particles in an accelerator, to model a nuclear explosion without actually exploding bombs, to calculate complex interplanetary orbits or to trace the path of a hurricane.

It takes a long time to develop and manufacture a genuinely new supercomputer. It took several years for Cray

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to deliver the first Cray 2s. The Cray 3, a Cray 2, built with chips of gallium arsenide rather than silicon, is unlikely to appear before 1990. Europe does not want to be left out of the supercomputer business. At the end of last year, Esprit, the EEC's information technology programme, gave money to a joint Anglo-French project, coordinated by the RSRE. This project aims to develop a supercomputer over the next three years. Eureka, Europe's research initiative in advanced technology, has also approved a plan for two companies, Bull of France and Siemens of West Germany, to develop a supercomputer.

Elliott puts the transputer and Meiko's Computing Surface alongside these supercomputers in the battle of the ratings between the different companies that design and manufacture computers. He says that up to 1000 transputers would perform as well as the most powerful Cray. It is difficult to make reliable comparisons between different supercomputers, not because companies keep their performance figures secret, but because like is not always compared with like. The rate at which a central processing unit (CPU) processes instructions, the MIPS rating, is one yardstick of performance. Another yardstick refers to the number of arithmetical "floating-point operations" (flops) that a supercomputer completes per second, usually counted in millions (megaflops) or thousands of millions (gigaflops). Cray's XMP 416 can execute almost 2800 MIPS and 800 megaflops. It costs between $9·5 million and $16 million. The Cray 2 should improve these figures by 30 per cent. The newest computer from CDC's subsidiary, ETA, a machine with eight linked CPUs, will perform 10 gigaflops and cost $18 million. For comparison, DEC's VAX 8800 is rated at 11 MIPS and costs less than $1 million.

Home Office

How to find a fingerprint in a file of 3·5 million sets: find the major marks (left), then count the ridges in between

David Alden says that refined versions of Meiko's Computing Surface will assist in fluid dynamics and research on artificial intelligence. Computing Surface can produce a three-dimensional model of an oil reservoir, taking in many variables, such as pressure, volume, flow and seismic effects. The machine could model a North Sea oilfield on site on an oil rig, an option not available with the huge Cray machines. Similar computer models can tackle nondestructive testing of aircraft. Meiko has been asked to help model the way in which a fire starts and how it could be controlled. With large computers researchers may be able to set up models for research in bioengineering and pharmaceuticals to give great detail or to show reactions that happen very quickly. Software experts at Southampton University are exploring the possibility of building a machine, based on transputers, that is "dynamically configurable" That is, specific transputers in an array would decide how to allocate different parts of a parallel processing task to all the resources in the system.

These are just some of the uses planned for the new chip. In computing, new technologies can create applications in a way that we may not immediately foresee. The 16-bit microprocessors made cheap personal computers widely available within a few years of going into production. The transputer may put supercomputers on people's desks just as quickly. But all this will depend on the way in which Inmos is allowed to develop and market the transputer. A large cloud hangs over the company's future.

Just as the transputer is finding applications, Inmos' own future could again be in doubt. The company began life in 1978 with £25 million from the Labour government's National Enterprise Board. After a period of uncertainty about the company's future, between 1979 and 1984, a Conservative administration finally sold its stake in Inmos and it became a wholly owned subsidiary of Thorn-EMI.

Thorn-EMI's half-yearly returns to September last year showed a sharp drop in pre-tax profit from £40·2 million to £11·4 million. The company attributed £12·5 million of that fall to Inmos, though Inmos' profit for the equivalent period in 1984 was £2·6 million. Since that announcement, there have been hints that Thorn could get rid of or at least sell off part of Inmos.

The transputer, like Inmos' range of memory chips, has to be commercially competitive. To achieve that, the company needs reliable funds for development and a big marketing effort to win designers of computer systems over to the transputer. So the attitude of Inmos' parent company is crucial.

"We're very pleased with the reception the transputer has had, particularly in the US," says Iann Barron, director of corporate strategy at Inmos. Barron helped to found the company and he has been a driving force in the development of the transputer. "It has been recognised as innovative, now we have to prove it commercially," he says. "People are hesitant about a new product that competes with suppliers like Intel or Motorola. We're seen as a British company trying to succeed in what US firms consider their pet market." Barron claims: "We always felt nobody would believe in the transputer until it was a success in the market place."

Thorn-EMI has confirmed that it is seeking one or more partners to share the investment load in Inmos. "This has always been our intention," said a spokesman for Thorn-EMI. "We stated it as such to the government when we bought Inmos in September 1984." Thorn-EMI would prefer to retain a 51 per cent interest in Inmos, but would consider other options. In an ideal world, the best candidate for a minority investment would be a multinational concern that already bought significant amounts of Inmos' products.

That does not rule out the possibility that an American or Japanese corporation might decide to buy Inmos, and the transputer along with it. United Technologies, the owner of Sikorsky, has shown an interest in a role for the transputer in the Strategic Defense Initiative—Ronald Reagan's star wars. Inmos might yet go down the same road as Westland.

Whatever the outcome, British managers and scientists could lose a voice in the future of Inmos. "It's not terribly likely that a major new partner would be British," Thorn-EMI's spokesman admitted. Inmos is expected to break even by June this year.

The Department of Trade and Industry has so far refused to take a public position on Inmos' immediate prospects. Brian Oakley is the director of the Alvey Programme, a research project into advanced computers that involves industry and universities. He is more outspoken: "The transputer has been universally well received. It would be a tragedy if it were lost to the UK." Oakley describes the transputer as a development of major significance that he would not like to see fall into foreign hands. "It would be difficult to transfer the manufacturing facility and even more difficult to relocate the research expertise," Oakley says. "All the same, a reinforcement of the shareholding would be important for the development of the product. But it is to be hoped that Thorn-EMI retains control." □

Nick Anning is a staff member of *Computing*. **David Hebditch** is a contributing editor of *Datamation*.

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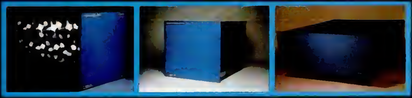
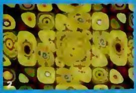


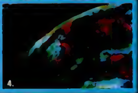
Comprehensive Software

1. *IP8000 series' high resolution 1K by 1K imagery, infrared color composite of Crater Lake. Remote sensing application courtesy of NASA-Ames Research Center.*



2. *Fast Fourier Transform (FFT). Gould DeAnza's new FFT programs can transform a 512x512 pixel image into a complex, 16-bit, block-floating FFT in 1.5 minutes.*

3. *CT scans used to model 3-D images of skull and facial tissue. Medical application courtesy of Mallinckrodt Institute.*



4. *Weather satellite data displaying graphic overlay capability. Remote sensing application courtesy of MacDonald Dettwiler.*

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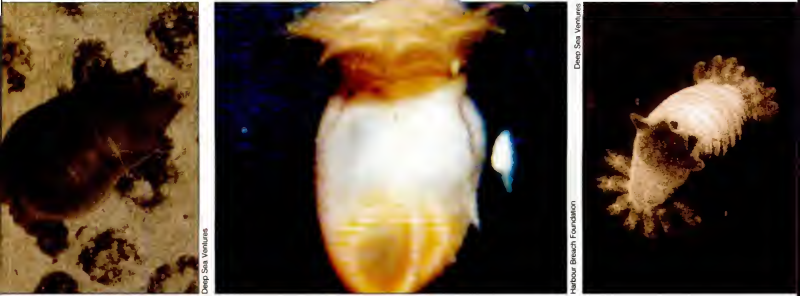
The rise and rise of the sea cucumber

Sea cucumbers are supposed to be long and cylindrical and to live at the bottom of the sea. Marine biologists are now finding that in the deep oceans these animals break all the rules and swim high above the ocean floor—and that there are more of them than they once thought

David Billett


Deep Sea Ventures
Deep Sea Ventures
Harbour Breach Foundation

A new species discovered on film: Peniagone leander *(left and right). Like* Enypniastes *(centre), it swims high above the sea floor*

IN 1874, scientists on a round-the-world oceanographic voyage aboard HMS Challenger captured some very odd animals. They did not realise it at the time, but they had found the first known specimens of swimming sea cucumbers—specialised animals that form a biological link between the ocean depths and the upper waters.

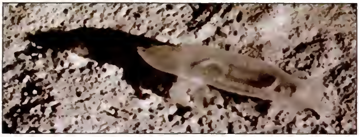
The ocean, and its community of plants and animals, forms an ecosystem—the largest in the world. Until quite recently, scientists had few opportunities to explore the inaccessible depths of the ocean. Now, with new developments in underwater technology, we can penetrate deep into the abyss and explore the darkest expanses of the seas. Submersibles, new techniques of deep-sea photography and sophisticated collecting gear have allowed biologists to discover a great deal about the fauna of deep waters. One discovery is that a specialised group of animals lives just above the seabed; this group forms the "benthopelagic fauna". (Benthic organisms crawl on, burrow in, or attach themselves to the seabed, pelagic animals swim or drift in the water.)

Benthopelagic fauna include fish and shrimps that seek out and devour the corpses of other marine animals, and those bizarre swimming sea cucumbers found by the scientists on HMS Challenger. We still know very little about deepsea cucumbers. Before 1975, marine biologists had found only a handful of specimens around the world. They now recognise that sea cucumbers are no longer novelties caught in trawls, but are abundant and important components of the benthopelagic fauna.

Sea cucumbers (holothurians) are related to starfish, brittle stars, sea urchins and sea lilies. Together, these groups form the phylum Echinodermata. Unlike the hard, spiny sea urchin or the stiff, armour-plated brittle star, most holothurians have a soft, leathery and sometimes gelatinous skin. The calcareous (bony) plates so characteristic of other echinoderms are smaller in holothurians and sparsely distributed in the skin. Other echinoderms are radially symmetrical but the holothurians are elongated—the mouth and arms are at opposite ends of a typically cucumber-shaped body. The term sea cucumber, however, hardly does justice to the more remarkable forms that some holothurians attain (Box 1).

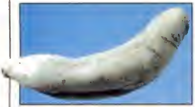
Holothurians move using their small tube feet—outward projections of an internal hydraulic system containing water—or by using the muscles of the body wall. Some species use the tentacles around the mouth to feed on particles of food suspended in the water. Most species, however, roam over the seabed, feeding on the top layer of the sediment. Adults of all the other groups of echinoderms, like most holothurians, live on the seabed or in the sediment, though some species can make short forays into the water above them. Swimming sea cucumbers, therefore, are unique among echinoderms in leading a truly pelagic life.

When swimming sea cucumbers evolved a pelagic lifestyle, their shape changed radically. Some species look more like a jellyfish than a cucumber. The most conspicuous adaptation for swimming is the fusion of the tube feet into brims and fans. The pelagic holothurians are very watery—more than 95 per cent of their weight is water—which makes them almost the same density as the seawater and therefore neutrally buoyant. Unlike benthic sea cucumbers, which have heavier skeletal structures, such as a ring of calcareous plates around the oesophagus and

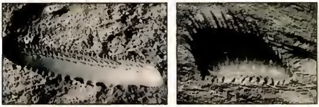


Caught but not recognised for 100 years: Peniagone diaphana

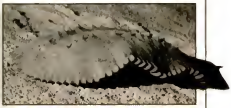
1: The fickle form of the sea cucumber



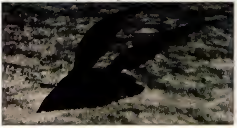
Pseudostichopus, *long and thin*



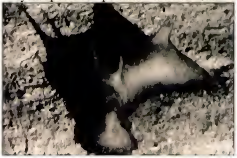
Benthogone *and* Laetmogone *walk on stumpy feet*



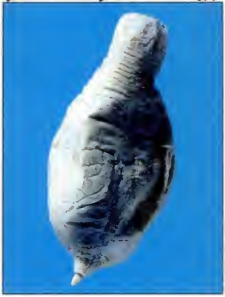
Paelopatides, *occasional swimmer*



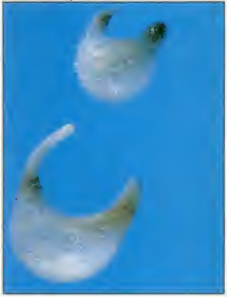
Psychropotes semperiana *with one "sail"*



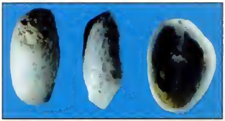
P. depressa *has smaller "sails"*



Molpadia *lives head down in sediment*



Ypsilothuria *and* Echinocucumis



Psolus, *behaves like a limpet*

All Photographs: IOS

IN THE FAR EAST, people prize sea cucumbers as a gourmet treat. Deep sea holothurians, however, are not noted for their palatability and they seldom resemble a succulent cucumber.

Some species, such as *Pseudostichopus atlanticus*, are long and thin but generally the tube feet and the sensory papillae are prominent and ornament the surface of the body. *Benthogone rosea* and *Laetmogone violacea*, for example, walk over the sea floor on stumpy feet arranged along each side of the body. They have rows of papillae on their backs.

Not all holothurians are cylindrical. "Sea cucumber" is a misnomer that dates from the days when all marine biology was done in rock pools with a shrimp net. The only holothurians caught that way did tend to look like cucumbers. However, some are distinctly flattened. A continuous brim of fused lateral tube feet surrounds the body of *Paelopatides grisea*. This holothurian usually crawls over the seabed on its small tube feet, arranged along the midline of the body, but *Paelopatides* can swim for short periods. Waves passing along the body, and its flat shape, aid its gliding movements once it is "waterborne". In contrast, *Benthothuria funebris* resembles a football. Two-thirds of its mass consists of watery connective tissue, which makes the holothurian almost neutrally buoyant.

In some species the papillae have developed in rather bizarre ways. *Psychropotes semperiana* has just one dorsal papilla that can be almost as large as the holothurian itself. The papilla is often referred to as a "sail" but no one knows its precise function. *P. depressa* has several enlarged papillae.

Some holothurians live within the sediment, and have adapted their bodies to this environment. *Molpadia blakei* apparently scrabbles around head-down in the sediment, maintaining contact with the surface via its small tail, through which it draws water into respiratory "trees" inside the body.

Other holothurians that live in the sediment are U-shaped and have well-developed calcareous plates that support the body wall. Two such species, *Echinocucumis hispida* and *Ypsilothuria talismani*, live with mouth and anus poking out of the seabed.

Psolus squamatus must be the most outlandish of all the holothurians. Typically it lives on rocks and boulders and bears a strong resemblance to a limpet, with a domed dorsal surface of several thick calcareous plates. Its ventral surface is only a thin membrane, through which its internal structure is visible. Unlike the limpet, the mouth of the *Psolus* penetrates its dorsal surface. The *Psolus* feeds by unfurling tree-like, branching tentacles that pluck suspended particles out of the water. ☐

calcareous deposits in the body wall, swimming sea cucumbers have few or none of these structures. The organic content of the body of a swimming sea cucumber is very low, accounting for less than 1 per cent of its wet weight, compared with 2 to 8 per cent in its benthic cousins. It is thus well suited to an environment where food is scarce, as it needs little nourishment either to form its body or to maintain its bodily functions.

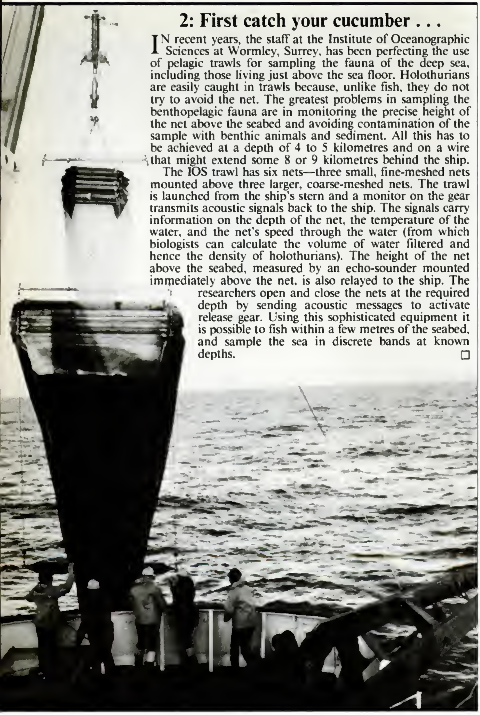
In 1891, biologists aboard the American steamer Albatross in the Gulf of Panama captured a new type of pelagic holothurian swimming above the seabed. Unfortunately, they did not have a device for opening and closing their net, so no one could say for certain what depth the specimens came from. They did see some sea cucumbers swimming at the surface of the sea. Since then, further reports have trickled in from other chance captures in trawls. People probably missed many other specimens because nets often reduce these fragile animals to an unrecognisable pulp.

The picture changed radically when scientists finally travelled into very deep water in submersibles. In 1974, American scientists made a series of dives to 2000 metres off southern California in the submersibles Sea Cliff and Turtle. They

2: First catch your cucumber . . .

IN recent years, the staff at the Institute of Oceanographic Sciences at Wormley, Surrey, has been perfecting the use of pelagic trawls for sampling the fauna of the deep sea, including those living just above the sea floor. Holothurians are easily caught in trawls because, unlike fish, they do not try to avoid the net. The greatest problems in sampling the benthopelagic fauna are in monitoring the precise height of the net above the seabed and avoiding contamination of the sample with benthic animals and sediment. All this has to be achieved at a depth of 4 to 5 kilometres and on a wire that might extend some 8 or 9 kilometres behind the ship.

The IOS trawl has six nets—three small, fine-meshed nets mounted above three larger, coarse-meshed nets. The trawl is launched from the ship's stern and a monitor on the gear transmits acoustic signals back to the ship. The signals carry information on the depth of the net, the temperature of the water, and the net's speed through the water (from which biologists can calculate the volume of water filtered and hence the density of holothurians). The height of the net above the seabed, measured by an echo-sounder mounted immediately above the net, is also relayed to the ship. The researchers open and close the nets at the required depth by sending acoustic messages to activate release gear. Using this sophisticated equipment it is possible to fish within a few metres of the seabed, and sample the sea in discrete bands at known depths. ☐



literally bumped into swarms of swimming holothurians drifting within 70 metres of the seabed. They saw hundreds of specimens of one species, *Peniagone diaphana*, discovered 100 years earlier by the researchers on HMS Challenger and which, until 1974, biologists knew from a mere ten or so specimens. The *Peniagone* were very patchy. During the course of a dive, the submersible passed from areas where holothurians were virtually absent to other areas where they were abundant. The sea cucumbers swam vertically, with their front ends upwards, sweeping the water about 20 to 30 times a minute simultaneously with their oral tentacles and a postanal fan of fused tube feet.

Since then, biologists have observed and collected other holothurians, in the northwest Atlantic from the American submersibles Johnson-Sea-Link and Alvin, and off Japan from the Japanese Shinkai 2000. These holothurians, species of the genus *Enypniastes*, have a fan of fused tube feet surrounding most, but not all, of the front end, perpendicular to the axis of the body. Two further brims of fused tube feet extend along each side of the body. The scientists have filmed the swimming behaviour of *Enypniastes* from the Johnson-Sea-Link. These cucumbers also swim with their front ends up; downward thrusts of the anterior fan produce forward and upward motion. The lateral brims provide some power but act primarily as stabilisers. The anterior fan beats about eight times a minute. Other holothurians use lateral brims to propel themselves in a manner similar to a cuttlefish as it idles through the water.

Although submersibles are valuable for observing and collecting pelagic holothurians and other deep-sea animals *in situ*, they are prohibitively costly to run. Only a few are suited to deep-sea work and the vehicle can cover only a small area in each dive. Most research using submersibles is carried out on the continental slopes, the steep inclines from the edge of the continental shelf to the deep-sea floor, leaving the abyss undisturbed and unstudied.

Oceanographers are working on alternative ways of exploring the deep sea. One method is to fit cameras to equipment that can be hauled along the seabed or hung several metres above the sea floor. Photographs taken in this way make it clear that the pelagic holothurians are the stars of the benthopelagic fauna of the deep sea. Some of these photographs are so good that taxonomists have described a new species from them, even though they cannot examine live specimens. This new species, *Peniagone leander*, which grows to a length of 30 centimetres, lives within about 50 metres of the sea floor, at depths of around 5000 metres in the Pacific Ocean. Biologists have also filmed pelagic holothurians from several thousand metres below the surface in the northeast Atlantic Ocean. Researchers at the Institute of Oceanographic Sciences, in Surrey, developed a camera for surveying large areas of the sea floor. They tow it about 10 metres above the seabed, so that each photograph covers approximately 80 square metres. An echo-sounder measures the precise height of the camera above the seabed each time a photograph is taken. If scientists know the total volume of water within the camera's view, they can calculate the abundance of the swiming sea cucumbers. In the various oceanic basins of the northeast Atlantic, close to the seabed, there are between 1 and 1000 swimming sea cucumbers per 100 000 cubic metres of sea. These densities might appear to be very low, but, compared with the densities of other animals, the deep sea is a hotbed of holothurians.

A link with the surface

Photography can provide information on behaviour and the density of swimming sea cucumbers close to the seabed, but we need other methods to sample them. Biologists must catch small animals that seldom show up clearly in photographs in order to examine them directly (Box 2).

Using a variety of trawling gear, marine biologists have collected pelagic holothurians throughout the northeast Atlantic. Some of these were only 2 millimetres long, and in excellent condition. The cucumbers are most abundant close to the seabed, but they also turn up hundreds and even

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thousands of metres above the sea floor. Those cucumbers collected within 200 metres of the bottom usually have sediment in their stomachs. They probably feed at the seabed. Those caught higher up in the water do not seem to have fed—not even on suspended particles. Although holothurians spend much of their time swimming, they do seem to depend on the sediment on the sea floor for food. The crews of submersibles have seen individuals of pelagic species of holothurians lying on the seabed cramming sediment into their mouths with their tentacles.

Why, then, do swimming holothurians travel such great distances above the seabed? The answer is a resounding "Don't know". Most of the high-fliers are juveniles of species whose adults normally stray no more than 500 metres above the sea floor. These species, like some of the benthic holothurians, reproduce by releasing large eggs that float upwards through the water. Fertilised eggs might develop directly into juvenile holothurians or they might go through a larval stage before developing into a juvenile—but this is unlikely. No one knows the height to which eggs rise, but some juveniles are regularly caught at depths as shallow as 1000 metres—up to 3400 metres above the seabed. Very occasionally, they also turn up at the surface.

Not all these oceanic travellers are juveniles. Marine biologists have found a few large specimens of *Scotothuria herringi*, a species discovered only in 1972, more than 3 kilometres above the sea floor. Biologists think that this species might be able to filter particles suspended in the water but they have yet to prove it. The specimens that they have captured close to the seabed have large guts packed with sediment. The structure of the gut is similar to that of the benthic holothurians, which suggests that this species prefers to feed on deposits. *Scotothuria* seems capable of migrating vast distances vertically. Why it bothers to, and how often it goes travelling remain a puzzle.

Swimming holothurians and pelagic juveniles of both benthic and benthopelagic species could act as vehicles carrying organic matter from the seabed up into the water. These movements represent one of the very few routes for upward transport of organic matter from abyssal depths. Most of the vertical movement of organic matter in the oceans is downward—as the wastes and remains of animals near the surface sink. Oceanographers are giving a lot of attention to the mechanisms of downward movements but there is little information on the processes of upward transport. Many animals in the top 1000 metres of the ocean undertake intrepid marathons of several hundreds of metres vertically each day to the surface and back. Below this depth, however, the pathways of upward transport are less well defined.

Some deep-living fish produce buoyant eggs, often enmeshed in a large mucous sheet, which rise to the surface of the sea, where they complete their development. Other fish release eggs that sink to the seabed and their developing larvae migrate back up to the adult's normal habitat. Both types of migration during development provide a mechanism for upward transport in the ocean. Some species of snails that live in the abyss also produce larvae that feed in the surface waters, before sinking back into the gloom whence they came. Some biologists believe the same phenomenon occurs in certain starfish, brittle stars and sea urchins.

Most people think of the deep sea as a remote environment, cut off from shallow waters and out of reach. However, recent discoveries suggest that the abyss is not so isolated as we imagine.

Pelagic holothurians might provide an important link between the sediments of the deep sea and the upper waters of the ocean. The frequency of their sorties and the distance to which they sally forth are problems that the new generation of "aquanauts" has yet to solve. ☐

David Billett is a biologist at the Institute of Oceanographic Sciences, Godalming, Surrey.

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Memory, molluscs and molecules

The molecular basis of learning eludes us. But slugs and snails are showing neurobiologists where in the brain they need to look

Georgina Ferry

WHERE DO we keep our memories? Theorists reply that memories reside in distributed networks of nerve cells that organise themselves in the light of their collective experience (*New Scientist*, 13 March 1986, p 36). But that answer presents a further question. What actually changes in the cells that constitute these networks when we learn something new? Whether memories last a few hours or a few decades, the relationship between one cell and another in the network must undergo a more or less enduring physical modification. If that is the case, one could equally well say that the memory is this physical change—or at least the sum total of the changes that take place as a result of a single experience.

With this definition to the fore, rather than a definition in terms of distributed networks, we can now go looking for physical memory traces in real brains. It is much easier (though still tricky) to study changes in individual cells or synapses (the junctions between one cell and another) than to trace the ramifications of a neutral network. The question at issue, discussed at a recent Dahlem workshop in Berlin, is how the brain's activity can by itself change the physical properties of its individual components, the nerve cells or neurons.

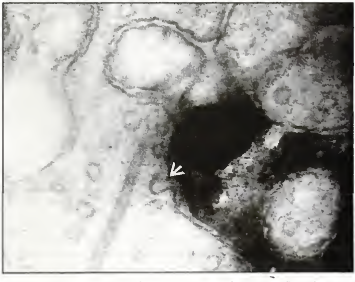
Changes that may be related to learning appear at several levels in the system. First, the circuits linking events in the external world with their representations in the brain have a limited scope for change, possibly including the formation and removal of whole synapses. Such wholesale and long-term changes in the structure the cell imply that the instructions from the genes have themselves altered. A second line of research investigates such changes, manifested by the appearance of new proteins. Finally, we now know much more about how activity in cells can alter their biochemistry so that they become either more or less responsive to their inputs. These changes are the first means by which the cell can register its experience. Any changes in the expression of the genes, which could have the effect of making a temporary change more permanent, can occur only as a consequence of them.

For many years the idea that memory involves the manufacture of new proteins has gone in and out of favour. Its initial attractiveness lay in the infinite flexibility of the genetic code. The countless memories we accumulate in our lifetimes could be matched by the countless possible ways in which the DNA and RNA could be influenced to produce different proteins. The idea that specific memories each had their own protein ultimately proved naive. A number of experiments claiming to show that "memories" had been transferred from one animal to another via extracts of brain tissue turned out to be irreproducible.

Other experiments were less easy to dismiss, although they had serious methodological problems. Beginning in the late 1960s, Bernard Agranoff, Samuel Barondes and others in the US found that substances that interfered with the synthesis of proteins prevented animals from retaining their memories of a task in the long term. The substances did not affect short-term memory, and they had no effect if they were given more than a few hours after the training session. But they also made the animals so ill that it was difficult to be sure their poor performance was really a failure of memory. This, and the problem that no one had any idea where to look for the proteins that were supposed to be involved in learning, put an end to this type of experiment for several years.

Recently, Eric Kandel and his colleagues at Columbia University in New York have dusted off the inhibitors of protein synthesis for another look. Kandel's laboratory has studied learning in the mollusc *Aplysia* (the sea hare, a large marine snail) and has succeeded in identifying the molecular changes that take place in cells involved in the learning of a simple reflex (*New Scientist*, 5 January 1984, p 18). After they have received a strong stimulus such as an electric shock to the tail, the animals are "sensitised" so that they give a strong defensive response—withdrawing the gill—even to weak stimuli such as a light touch on the mantle (the sheet of wavy tissue that protects the gill cavity). If no further shocks follow, the sensitisation wears off within half an hour. If they experience the shock repeatedly, the animals remain sensitised for longer. Inhibitors of protein synthesis can prevent this long-term sensitisation while leaving the short-term version unaffected.

Further work from Kandel's laboratory demonstrates unequivocally that the inhibitors of protein synthesis act at the same site as the changes involved in the learning, rather than affecting the whole animal non-specifically. Samuel Schacher and Piergiorgio Montarolo have isolated the cells involved in the response (a sensory neuron that records the touch on the mantle and a motor neuron that contacts the gill muscle) and reconstructed the connection between them in a culture dish. They can simulate sensitisation of this connection's response over both the short and long term by adding single or multiple applications of serotonin, the neurotransmitter chemical that is released in the whole animal when it experiences a shock. Inhibitors of the synthesis of protein or RNA (the messenger molecule that carries the genes' instructions from the nucleus to the cytoplasm where proteins are made) again block the long-term response but not the short-term one. James Schwartz and Vincent Castelluci have compared the proteins extracted from *Aplysia*'s cells before and after long-term sensitisation, using the technique of two-dimensional gel electrophoresis, which separates proteins according to their molecular weight.



Prof M. Djamgoz & Dr J. Downing/Imp College/SPL

Electron microscopy reveals a synaptic vesicle (arrowed) in the act of releasing its neurotransmitter at a synaptic junction. Changes in the molecular mechanisms that control this process could form the basis of all our memories

Seaphot/Planet Earth

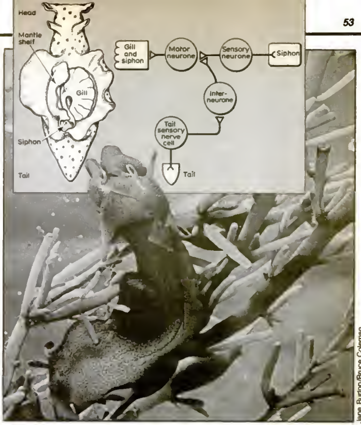
The elegant sea slug Hermissenda *can learn simple associations, the molecular basis of which may also apply to mammals . . .*

They find several new proteins in the gels from the sensitised cells.

The identities and roles of these proteins remain unknown, but there are various possibilities. The transcription of DNA to RNA depends to a certain extent on regulatory proteins that bind to the DNA molecule and influence whether (or how effectively) the gene will be transcribed. A cell's activity may modify some of these proteins (at least two ways of doing this are possible) so that they in turn affect which gene sequences are transcribed and which proteins are synthesised. This might have the long-term effect of increasing or decreasing the efficiency of the synapse by altering the area of active contact between one cell and the next, if not of actually changing the number and distribution of its synapses. Alternatively, it might influence the production of enzymes that regulate crucial steps in the transmission of electrical signals from one cell to another.

No clear-cut examples have yet come to light to show that learning changes gene expression, but neural activity can undoubtedly regulate the production of proteins. For example, muscles that have been deprived of their neural input become supersensitive to the neurotransmitter acetylcholine (the chemical that carries the signal to contract from nerve to muscle). Deprived of their accustomed activity, they produce far more than the usual number of acetylcholine receptors, the specialised proteins that respond to molecules of the transmitter by bringing about physical changes that induce the muscle to contract. Jean-Pierre Changeux and his colleagues at the Institut Pasteur in Paris have used techniques derived from genetic engineering to show that paralysed muscles produce much more RNA coding for one of the subunits of the acetylcholine receptor than those which are not paralysed. Under normal circumstances, it appears, activity in the muscle induced by its neural inputs directs the genes to reduce the production of acetylcholine receptors to an essential minimum.

The intervening steps in this process have yet to be worked out, and in the case of learning they present an intriguing problem. Any cell can be active without being involved in learning; what might the difference be between such general activity and activity that might lead to something being remembered? The lead in studying this problem belongs not to students of such cerebral creatures as rats and humans, but those interested in the nervous system of the humble mollusc. Slugs and snails learn rather little, but their nervous systems are simple enough that specific cells can be identified from one individual to another, and it is possible to draw up wiring diagrams of the circuits involved in learning simple tasks. While the nervous system of mammals are radically different in their organisation from those of snails, the biochemistry of the individual cells changes rather little from sea slug to human. So studies of the biochemical changes that take place when a slug learns should at least give us a clue as to the sort of changes we should be seeking when we look for traces of learning in more complicated brains.



Jane Burton/Bruce Coleman

. . . while its rival Aplysia*'s simple circuits seem to use a different, though equally plausible, mechanism*

There are two species of snail that occupy the most attention. One is *Aplysia californica*, the object of study in Eric Kandel's group at Columbia; the other is *Hermissenda crassicornis*, studied by Dan Alkon and his colleagues at the Marine Biological Laboratory at Woods Hole in Massachusetts. In each case the animals are conditioned to respond defensively to a stimulus that would not normally provoke such a reaction (the conditioned stimulus) by repeatedly pairing it with another stimulus that they definitely wish to avoid (the unconditioned stimulus). After this training, the scientists look for changes in neurons where activity triggered by the conditioned stimulus converges with that triggered by the unconditioned stimulus.

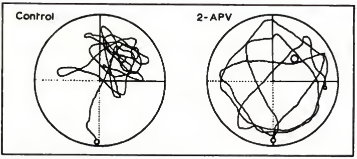
In each case the researchers have been rewarded by the discovery of a cascade of biochemical changes in the cell whose output eventually determines how the animal will respond. The cascade is triggered by activity in that cell *coinciding* with an input from elsewhere in the system. This coincidence of activity in two or more cells seems to be a key requirement for the changes that underlie learning. An active cell undergoes fluxes of different types of ion through its membrane, as special channels open in response to the changing voltage. In these two molluscs, the flow of calcium ions into the cell seems to be a crucial early step in the cascade. And in each case the final step is that an enzyme (a protein kinase) alters (through phosphorylation) the structure of proteins related to the channels in the cell membrane that allows potassium ions to flow out of the cell, thereby closing the channels. These potassium currents are necessary to return the cell from an excited (depolarised) state to a resting state. If they are slowed down, channels that allow calcium to flow in as long as the cell is excited stay open longer; in turn, the high levels of calcium enable the cell's terminals to release more neurotransmitter, increasing the output of information from the cell. This has the effect of strengthening its connections with the cells it communicates with.

Unfortunately for the tidy minded—if things were not complicated enough already—the intervening steps differ considerably between the two kinds of snail (see Box). Different enzymes phosphorylate the proteins, different "second messengers" (chemicals that carry out further changes within an active cell) activate the enzymes. Even the exact type of potassium current is different in the two models. Arguing about the respective merits of each seems a fruitless exercise, however; they have enough in common with each other and with other systems that have been studied to lead in useful directions. It would be stretching the law of parsimony to ridiculous lengths to expect identical mechanisms everywhere we look.

Just what can we expect when we look at the brains of animals a bit more like us? We are still very much in the dark about the exact circuitry involved in learning in mammals, which makes the task that much more difficult. One area that does seem to be important in some kinds of memory is the hippocampus. This seahorse-shaped structure sits just below the cerebral cortex (the "thinking" part of the brain) and has many connections both with the cortex and with deeper brain structures. Animals and humans with damage to the hippocampus have various kinds of memory problems. In the 1970s, Tim Bliss of the National Institute for Medical Research and his colleague Terje Lømo in Oslo discovered that a certain type of input to the hippocampus could cause long-term changes in the way its cells responded. If they implanted electrodes in one of the pathways leading into the hippocampus and gave short bursts of high-frequency stimulation, the connections between that pathway and the area it communicated with were strengthened for at least several weeks. They called this phenomenon *long-term potentiation* (LTP).

Bliss and others have since been interested in finding out exactly what goes on at the potentiated synapses. It turns out that there are some similarities with the story of the snail. Again, the convergence of several inputs on to one cell simultaneously seems to be crucial, as is the flow of calcium into that cell. In addition, enzymes probably bring about long-lasting changes in the structure of specific proteins through phosphorylation. One result of this might be to alter the physical structure of the synaptic sites.

Richard Morris MRC Neuroendocrinology Unit



In the water maze, rats have to find a platform under cloudy water and remember its location. If the platform disappears, the path they follow concentrates on the quarter of the pool where it was previously. But given a drug that blocks long-term potentiation, they swim about aimlessly (above right).

Until recently, LTP remained an interesting phenomenon with no obvious connection to learning. But Richard Morris and E. Anderson of the MRC's Cognitive Neuroscience Research Group in St Andrews, Scotland, working with Gary Lynch and Michel Baudry of the University of California at

Two molluscs, two molecular mechanisms of learning

DAN Alkon was the first to demonstrate that a mollusc, the sea slug *Hermissenda*, could learn to associate two different signals. These animals normally approach light, but respond defensively to rotation (as might you or I if spun on a turntable at 97 rpm). By repeatedly pairing light with rotation, Alkon inhibited them from moving towards the light.

Alkon traced the source of this change in behaviour to a circuit of cells linking receptors for light to statocysts, organs that detect acceleration. Specifically, training enhanced the response of one of the photoreceptors, called a beta cell. The beta cell's activity inhibits alpha photoreceptors, which are more directly involved in mediating the animal's response to light.

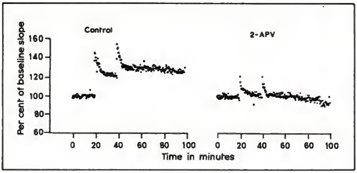
Using delicate techniques for recording from inside the beta cell, Alkon identified its increased activity as being due to the reduction of two kinds of potassium current (there may be four or more of these), known as I_A and $I_{Ca^{2+}-K^+}$. He attributed the reduction of these currents to an influx of calcium, triggered by the cell's depolarisation in response to light and enhanced further by the synaptic input from the rotation-detecting circuit. The reduced flow of potassium out of the cell prolongs the depolarisation, so even more calcium comes in, thus completing a positive-feedback cycle. The calcium may exert its effects on the potassium currents by activating an enzyme that phosphorylates the proteins of the potassium channels. The switching of protein kinases from an inactive to active state may be more or less permanent, offering a route to long-term synaptic changes.

Eric Kandel has also taught *Aplysia* to associate a gentle touch with an electric shock. Subsequently they defensively contracted the gill and mantle in response to the gentle touch.

At the level of the cells involved, Kandel described a cascade of changes that brought about the change in behaviour. The output of the sensory cell that detected the gentle touch was increased. Again, the immediate reason seemed to be a reduction in potassium currents, but the current involved was I_S, not either of the currents implicated in Alkon's model. A protein kinase phosphorylates the channel proteins, but it depends for its activation on cyclic AMP (adenosine monophosphate, a so-called "second messenger" in the cell), not calcium. The levels of cAMP rise because of the action of another enzyme, adenylate cyclase, which in turn goes to work when a neurotransmitter, serotonin, binds to receptors at the terminals of the sensory cell.

The serotonin arrives from a cell involved in registering the electric shock. Its effect on adenylate cyclase is greater if the sensory cell is already depolarised (as it would be if it had just detected a touch)—and therefore has high levels of calcium. Again, levels of calcium are driven even higher when potassium channels close, and the high levels increase the amount of neurotransmitter that the sensory cell releases on to the neighbouring motor cell, exaggerating its response.

Both Alkon's and Kandel's suggested mechanisms for learning can account for short- or long-term memory, depending on whether changes such as the reduction in potassium currents are temporary or permanent. Both have been developed through meticulous and thorough experimentation. Both, despite their apparently fundamental differences, provide valuable insights into the kinds of molecular mechanisms underlying learning. □



High-frequency pulses after recording for 20 and 40 minutes increases the baseline response of cells in the hippocampus (left); but the drug 2-APV blocks this increase (right)

Irvine, have just revealed a direct link between LTP and at least one kind of learning (*Nature*, vol 319, p 774). The neurotransmitter that carries information across the hippocampal synapses involved in LTP is the excitatory amino acid glutamate. There are at least three different kinds of receptor for glutamate on the postsynaptic cell. One, known as the NMDA receptor, is not involved in normal transmission across the synapse. But it does seem to be essential to LTP, probably through affecting the potential across the cell's membrane and hence the amount of calcium that can enter. A chemical called 2-amino-5-phosphonovalerate (2-APV) blocks the NMDA receptors; it also prevents LTP from being induced while not affecting normal synaptic transmission.

Morris and his colleagues looked at the effect on learning of infusing 2-APV directly into the brains of rats, close to the hippocampus. The rats had to swim about in a pool of cloudy water until they found an underwater platform which they could climb on to. One group that had received 2-APV was slow to learn where the platform was in the first place, and never managed to learn its new location when it was moved. Normal rats, in contrast, learned the task quite quickly. On a different test that did not involve using spatial cues to learn the position of the platform, there was little difference between the two groups, showing that the problems of the 2-APV group were specific to spatial learning.

This experiment, that LTP, or something very like it, is involved in learning, is the first demonstration of such a connection in mammals. There now seems little reason to doubt that learning depends on modifying the physical state of cells at their synaptic connections, and that such modifications can be triggered by cooperative activity in two or more cells. Beyond that, the research so far has opened many tantalising windows on to the possible ways in which activity is translated into "hard copy" in the brain. One important question concerns the identity of the protein whose production may play some role in making sure synaptic changes are permanent. Plans are afoot to trace them with genetic probes or label them with specific antibodies, techniques that have only recently become available. Even more intriguing, it might be possible to label all the cells involved in learning a particular response—at least in a relatively circumscribed area such as the hippocampus—and reconstruct from microscopic sections a map of the whole network. At a more mundane level, much work still needs to be done to clarify the roles of ionic currents, activation of enzymes and phosphorylation of proteins in both long- and short-term memory. Once these mechanisms are fully understood, the way will be open to develop drugs that may help people with ailing memories—or even to sharpen up the mnemonic powers of the merely absent-minded. □

Georgina Ferry is a freelance science writer and broadcaster specialising in psychology and neurobiology. This article is based on the Dahlem Workshop on the Neural and Molecular Basis of Learning that took place in December. The proceedings will be published by Springer later this year.

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REVIEW

Did Baird conceal his tracks to radar?

The Secret Life of John Logie Baird
by Tom McArthur and Peter Waddell, *Hutchinson, pp 274, £16·95*

Barry Fox

TEN YEARS ago Dr Peter Waddell, lecturer in mechanical engineering at the University of Strathclyde, Glasgow, wrote an article for *New Scientist* to commemorate the 40th anniversary of the BBC's electronic TV service ("Seeing by wireless", 11 November 1976, p 342). The thrust of the article was that history had treated Baird unfairly. It ended with the tantalising hint that many secrets on Baird's career had still to be unravelled. "Particularly," wrote Waddell, "the use of infrared and radar . . . up to and during the Second World War."

The Secret Life of John Logie Baird, which Waddell has now written with journalist Tom McArthur, attempts to unravel the story. The publishers make bold claims. The book, says Hutchinson, "radically rewrites the entire acknowledged histories of television, radar and secret signalling". Baird made his television breakthrough in a "jungle clearing in Trinidad in 1919", not Hastings in 1923 as popularly accepted. During the Second World War he was a "top-secret boffin". He was then years ahead in radar research and "a veritable Leonardo of the 20th century".

Although no one can blame a publisher for trying to sell books, such claims do leave authors, especially academics, with an awesome responsibility.

The historical research, presumably mostly by Waddell, is beyond reproach. It leaves no doubt that the history of television and radar is nowhere near so neat and tidy as textbooks and scientific folklore suggest. The book systematically destroys the popular myth that radar was born when Robert (later Sir Robert) Watson-Watt picked up radio reflections from an RAF Heyford bomber on 26 February 1935, using the BBC transmitter at Daventry.

This view tallies with that of Professor R.V. Jones in his book *Most Secret War*. The *GEC Journal of Research* also recently acknowledged much earlier experiments on detecting radio waves reflected from solid objects. Watson-Watt was an unpopular man lucky enough to be in the right place at the right time.

McArthur and Waddell have done sterling work in cataloguing the early work; it is when they go on to try to prove that Baird was the true father of radar that the cracks show.

Were Baird and his associates waging a secret war against the Axis powers using ultra-high speed signalling by television?

In 1923, Baird and four boy scouts hauled a saucer-like metal dish, battery and glass screen up to the hills over Hastings. One of the scouts recalls that the screen seemed to be made of iron filings and there was something moving on it—"a brownish picture, not quite a picture". The authors have found a widow who recalls her husband making small rectangular components which might have been something to do with what we now call radar.

In the mid-1920s, Baird filed a series of patents (288 882, 292 185 and 297 014) on methods of seeing with invisible radiation, for example infrared and radio. These show a spark-gap transmitter, radio lens of bitumen or sulphur, and a display panel covered with small metal particles. An image of the received signal is formed on the panel by sparks between the particles. McArthur and Waddell believe that the dish and spike on the hills at Hastings were working prototypes. Perhaps so, but does this really make Baird the father of radar?

Baird, they say of the Hastings years, "would later encourage misleading versions". To illustrate "the lengths to which Baird would go to disguise his work" they refer to an account, which appeared in an evening newspaper in Dundee in 1958, of a TV demonstration in 1926.

The journalist involved describes a Baird system (which produced pictures of him and a friend) with two scanning discs connected by string, knotted through each hole. McArthur and Waddell say that this is "an impossible contraption", and presume that the television pictures seen in another room "were captured by a genuine machine operating unheeded close up". But Baird's TV patents show simple, primitive mechanics. Could a second machine with spinning wheels really have passed unnoticed?

Engineers who worked with Baird ten years later, when the BBC and Post Office were at the point of ditching his mechanical system in favour of all-electronic equipment from Marconi-EMI, were still unimpressed. Bruce Norman, in *Here's Looking at You*, a history of British television, quotes one engineer: using the Baird system, the engineer said, was "like playing with clockwork when we'd already got electricity. The bloody thing just wouldn't work. We couldn't get rid of it quickly enough."

The authors surmise that in the late 1920s, when Baird was looking calm and cheerful, he "must have been working with frenetic zeal" and the most likely explanation of his silence on radar inventions was that they "were the subject of much eager curiosity from foreign powers".

"It seems likely" they write, that the government was trying to keep Baird's work on radar secret. He "had a contract to develop a bomber guidance system for the French government" and a possible order to do the same for the Russians. Yes. But did he deliver the goods?

A Mr Hecht of the Air Ministry visited Baird's company and found a "chaotic situation". The authors put this down to the pressures of his work for the Air Ministry, the television contest with Marconi-EMI and a fire at Crystal Palace which destroyed £100 000 worth of his equipment. Another explanation could be that Baird's company was just plain chaotic.

This information, according to McArthur and Waddell, is particularly valuable "as no other indication has ever been located of the Baird company's involvement in secret contracts for the British government and other foreign powers". A letter shows that Baird was going to demonstrate his equipment to Sir Henry Tizard and Robert Watson-Watt. "There was not, nor has there been since, any public record on his wartime involvement in radar," they say. Baird's widow told me three years ago that the family knew nothing of any such work. But the authors use the absence of proof as evidence in support of their claims.

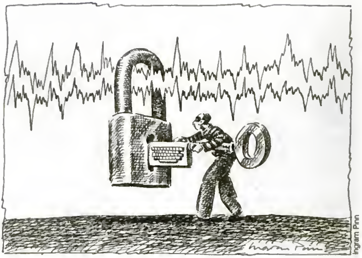
In 1944, Baird was working in the garage of his bombed house in Sydenham, surrounded by heaps of broken glass, demolished furniture and behind shutters blasted by flying bombs. McArthur and Waddell believe it was all part of the smokescreen. Of course it could have been. We shall never know for sure.

The Secret Life of John Logie Baird will entertain or annoy, depending on who reads it. But I cannot help wondering whether Dr Waddell would let his student get away with drawing conclusions comparable with some of those that appear in this book. □

Whistles and burps

The Radio Hacker's Code Book
by George Sassoon, *Duckworth, pp 239, £6·95*

Andy Thomas



Ingram Pinn

THIS exotic book is in the best tradition: enthusiastic, amateur and stimulating. It is not, as you might expect from its title, a catalogue of the whistles and burps carried over radio waves; it is more a computer odyssey than a guide to radio interception. That apart, there is much to encourage the computer snooper to move to the radio waves.

The budding radio enthusiast will find a competent description of radioteletype (RTTY) systems. In these, information is encoded before transmission as radio waves, and they are widely used in, for example, international telex operations. There is also a discussion of some of the other advanced data transmission methods, in particular forward error correction (FEC).

The challenge to the hackers is to intercept these radio signals and then to decode them. For this, they may use a microcomputer, feeding the whistles and burps via an audio loudspeaker plugged into their computer. Others prefer to build little boxes to do the intercepting and decoding. George Sassoon's predilection is the computer. He lists his programs, for the Sinclair Spectrum and Research Machines 380Z, which translate the RTTY codes into ASCII which the computer can understand. Sadly, he does not discuss the custom-built units before moving on to the techniques of breaking into encrypted messages.

At this point, the reader could well pause and ask why one should want to intercept and break into coded messages. I would agree with Sassoon that "the armed forces of all nations use RTTY extensively and many of their transmissions are in plain language and making interesting reading", but he fails to give legal guidance on intercepting non-broadcast radio emissions. He also conveniently ignores the moral problem of intercepting such transmissions.

North Sea oil rigs, or for that matter coastal radio stations, would rightly object to hackers intercepting their personal or commercial telegrams sent on FEC. So, undoubtedly, would Interpol, which will find its transmission schedule, frequency and mode printed on page 55. As the author comments, in a concluding homily, "information which is confidential or valuable . . . should be protected against unauthorised access". How, then, does he justify his book?

For clarity of presentation, the chapters on codes and ciphers are excellent. Sassoon gives us a quite remarkable program, for the Sharp PC-3201, which encrypts and decrypts the cipher for the German wartime machine, Enigma. As he rightly says, the Western powers have draped a veil of secrecy over Enigma since the 1940s, probably because they sold it to less developed countries in the 1950s. Possibly, too, this program would compromise the American M-209 cipher device, which has the same roots as Enigma.

From the principles discovered in programming Enigma, Sassoon leads the cryptographic discussion to public-key encryption systems and, in particular, the "RSA cipher" which is organised around two massive prime numbers.

In a lengthy section, he gives the clearest possible exposition of the RSA cipher and implements it on his Sharp. As with the Enigma program, the information is interesting and impressive, but it is hard to imagine an amateur intercepting, let alone breaking, a message encrypted in this way. Sassoon gives some hints on decoding, and challenges would-be cryptoanalysts to read his enciphered messages. (Are you reading this in Cheltenham?)

Perhaps the main strength and weakness of *The Radio Hacker's Code Book* is that its chosen path is idiosyncratic, one suspects personal. But if some newcomers find the book difficult as a result, older souls will recognise the lonely road the author treads. Without a doubt, it will inspire future attacks on "secret" radio communications. □

Gallic rigour and clever tricks

Artificial Intelligence: Promise and Performance
by Alain Bonnet, *Prentice-Hall, pp 221, £9·95*
The Hitch-Hiker's Guide to Artificial Intelligence: BBC BASIC Version*
by R. Forsyth and C. Naylor, *Chapman & Hall, pp 262, £8·95*

Martin Counihan

ALTHOUGH both intended for a popular readership, these two paperbacks could hardly be more different in philosophy and style. Alain Bonnet approaches artificial intelligence (AI) with Gallic rigour and seriousness, careful to provide a thorough, fully referenced account of the history and current status of an important new academic discipline. *The Hitch-Hiker's Guide to Artificial Intelligence*, by contrast, is a light-hearted romp.

Interestingly, Bonnet defines AI as "the discipline that aims to understand the nature of human intelligence through the construction of computer programs that imitate intelligent behaviour". By this definition, AI can be regarded as a research method for cognitive psychology rather than a branch of computer science. And maybe that's the healthiest way to look at it: AI is otherwise a disunited collection of overhyped ideas.

Bonnet's well-informed book packs in 20 chapters reviewing natural languages, knowledge representation, reasoning, expert systems and prognostications about the applications of AI. Commercial systems today are still fairly primitive, but Bonnet argues that over the next few years the market will be flooded with systems which, in response to questions in natural language, can extract information from databases.

For Richard Forsyth and Chris Naylor, AI is the "department of clever tricks" of computer science, concerned with all the leading-edge problems, but accessible to everyone now that today's home micros are as powerful as the mainframes which AI researchers were using 15 years ago. Professionals may well fear that a version for a microcomputer, however well written, must inevitably trivialise the subject. The authors believe that you don't need LISP or PROLOG or the like: it's the concepts that count, and they can be expressed in any language.

Forsyth and Naylor have some interesting things to say about computer creativity, but I'm repelled by their belief that "99 per cent of the human race is totally devoid of creative spark" and that "creative intelligence must be the ultimate goal of AI". Isn't that profoundly pessimistic?

For me, the fascination of AI lies in its connections with a host of other disciplines. Unfortunately, the new vocabulary of AI can obscure those links. For example, AI uses pattern-matching techniques, identifying the configurations of the frequency and timing which characterise significant sounds, to understand human speech: but haven't radar engineers and others done similar things for years? And isn't image processing already becoming a fine art in the context of remote sensing of the environment? Biological genetic systems build up and replicate information in ways not irrelevant to the design of knowledge bases in AI. And what about modern theories of human learning—don't they have something to do with how expert systems can be envisaged as learning and "learning to learn" at higher levels? AI is still a young subject, and it is no discredit to these two valuable books that they raise more questions than they can hope to answer. □

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* Apple version also available now, price £8.95. Editions for the IBM and Amstrad to be published in April.

Saving rocks for the future

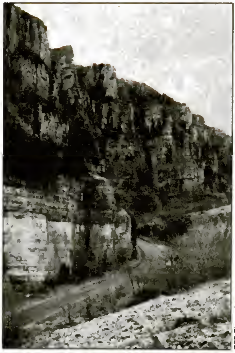
New Sites for Old: A Students' Guide to the Geology of the East Mendips
edited by K. Duff, A. McKirdy and M. Harley,
National Conservancy Council, pp 189, pbk £8·50

Derek Ager

EVEN THE rarest animals and plants may breed and build up their numbers again, but once a rock or a mineral or a fossil has gone, it is gone for ever. The conservation lobby tends to concentrate so much on furry, cuddly and pretty living things that all but geologists forget that there is another side to our national heritage which is not reproducible. There must be many treasures of our geological past stored in cardboard boxes under beds or in cupboards until they are ultimately thrown away.

Britain is fortunate in as much as the sea constantly renews great lengths of glorious rocky cliffs (unless some officious local authority covers up the glorious geology with concrete). Inland the situation is more difficult. Clay and sand pits are soon overgrown and hidden if they are not continuously worked. Quarries flood, are used as rubbish dumps or are fenced off by owners fearful of legal liability.

So it is that a few classic areas of our island tend to be visited over and over again by parties of geology students from universities, polytechnics and schools; every rock shows the marks of their hammers. One such area is the splendid ridge of the Mendip Hills in Somerset with their cliffs and caves, quarries and mines in the Carboniferous Limestone, plus some Silurian volcanics, some Devonian Old Red Sandstone, and a cover of Triassic and Jurassic sediments.



The Mendips—well hammered

GSF Picture Library

Every geology student knows, or should know, the long history of lead mining here, the tiny mammal-like reptiles preserved in fissures, the famous cave systems, the Triassic breccia banked up against the old hills and the classic unconformity near Frome where the Mid-Jurassic sea spread over the rocky limestone islands.

Unfortunately they are too well known and too well hammered. But there is no other way of training students in the study of the history of the Earth and its resources.

Now the Nature Conservancy Council (NCC) has made a great and highly commendable effort to provide students with access to the fascinating rocks without risking their loss to future generations of aficianados of the noble profession of the hammer. This guide represents an entirely new approach to geological conservation.

With remarkable perseverance, and highly commendable collaboration on the part of the landowners concerned, the NCC has obtained permission from all the landowners concerned for bona fide parties of geology students to visit no less than 39 different localities. With even greater originality, it has solved the problem of the over-visited localities by providing alternatives. These are every bit as good in scientific content as the classic sections.

Unfortunately there are a number of minor slips in this useful guide, but no doubt they will be corrected before it goes to many future reprintings. ☐

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* from NCC, Northminster House, Peterborough PE1 1UA. Price includes p&p.

EVOLUTION
AND THE
NEW PHYLOGENY
By Derek Bryce
Reviews both sides of the controversy over the
punctuated equilibria
model of the fossil record. It includes a new theoretical approach to speciation, linking genetics with ecology, which aims at resolving problems such as the apparent 'quantum' speciation of some US paleontologists, species flocks in cichlid fish, and the origin of mimicry in butterflies. A small, but important book of special interest to **geneticists** and **paleontologists**, it is a useful **updating** work for all **biologists**.
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Llanerch Enterprises, Llanerch, Felinfach, Lampeter, Dyfed, Wales. SA48 8PJ.

Distinguishing between now and then

Physics and the Ultimate Significance of Time
edited by David R. Griffin, *State University of New York Press, pp 322, $44·50 hbk, $14·95 pbk*

John Polkinghorne

MOST of us would agree with St Augustine that we know what time is—until we come to think about it. Then the perplexities begin. Fundamental physicists study interactions which are almost perfectly reversible, with no asymmetry between past and future. They have sometimes asserted the counter-intuitive proposition, expressed by Einstein in a letter to Max Born, that "the distinction between past, present and future is only an illusion, even if a stubborn one". As with many other such reductionist statements, one has an acute sense of its unreality. The temporal dualists are closer to common sense. They see asymmetric time as an emergent at the level of systems of sufficient complexity, most popularly with the thermodynamic property of increasing entropy or, in more extreme formulations, with consciousness. Finally, there are those (sometimes called pantemporalists) who assign a fundamental role to time, making it prior to any construction of physics.

Among the latter is to be found Alfred North Whitehead. His process philosophy assigns ultimate reality to events. Each event possesses a duration in which there is a quasi-subjective experiencing of past and present (concrescence, in the jargon) followed by an objectification (superjection). Whitehead is one of the thinkers considered in some detail at the conference whose matured reflections constitute this volume. The others are David Bohm and Ilya Prigogine.

Bohm has been constructing a way of thinking about the world in terms of a duality of explicate/implicate orders, enfolded into each other in a way for which the relation of hologram to object is taken to be a parable. Prigogine is well known for his work on the thermodynamics of dissipative systems far from equilibrium, leading to an understanding of how microscopic being can lead to macroscopic becoming. His view of time is dualist.

Everyone needs a metaphysic, a view of reality wider than the strictly scientific. However metaphysics is only persuasive if it bears a consonant relation to the insights of physics. Prigogine's ideas are most closely rooted in physics and he is least pretentious in his metaphysical construction. Bohm invokes physics, but often in ways that seem puzzling rather than helpful, as when he seeks to relate his notion of implicate order to the fluctuating quantum vacuum. Whitehead's metaphysics seems to me to be unanchored in the actual structure of the physical world. He and Bohm really offer us visions of wholeness, rather than understanding of how it might be so.

The book presents summaries of these thinker's views (in the cases of Bohm and Prigogine by themselves) and a good many extended comments thereon by other contributors. Many of the latter are excessively respectful to the less than totally coherent ideas to which they were directed. The most interesting contributions are the two written by the editor, David Griffin. The result is a book with a great deal of philosophical speculation but not a lot of contact with physical ideas. ☐

After 50 years of comet

The Mystery of Comets
by Fred L. Whipple, *Cambridge UP, pp 276, £12·95*

David W. Hughes

HAVE you had enough of comets to last you a lifetime? Do you echo the sentiments: "We wish to remark that our idea of nothing to see is Halley's comet... An expiring Chinese Lantern with its candle guttering in the last gasp at a church sociable and strawberry fete after the festival folk have gone home and the janitor had stacked up the chairs would present a magnificent and awe inspiring spectacle compared with this gaseous fraud" (the *Chicago Daily Tribune* of 26 May 1910).

Are you astronomically aching to return to Uranus, Cepheid variables, B Lac objects and missing galactic mass? Well before you do please read Fred Whipple's book. You will not regret it. When one of the great pioneering experts in any specific field of science takes time to stand back from his research and write, for the general audience, a detailed account of why he finds that subject *so* fascinating that he can happily spend a lifetime working in it, we must be specially grateful.

Whipple, 50 years after becoming a comet man, designed the dust shield for Giotto

Julian Baum/SPL

Whipple has been a comet man for over 50 years. In 12 years at the start of his career he discovered six new comets, scanning some 70 000 glass negatives with a hand-magnifying glass in the process. He followed this by an investigation of the orbital perturbations suffered by Comet Encke and the efficacy of comets as the prime source of dust for the Zodiacal cloud.

In the mid-1940s, people were worried about the source of the gas and dust emitted by comets each time they passed close by the Sun. The old flying gravel swarm model was inadequate. Whipple proposed a dirty snowball one, the loss of a metre or so of snow providing the gas. A rotating snowball acted like a small jet engine and explained the slight orbital variations. Snow sublimation produced ample pressure to form meteoroid streams. Whipple's analysis of the haloes in the coma even gave the spin period. For the past few years Whipple has been a co-investigator on the Giotto camera team, and he can take credit for being the inventor of the bumper shield designed to protect the craft from dust impacts when it flew through Halley's comet.

Halley's comet might have been difficult to find in 1985 but it doesn't make comets per se any the less exciting. Whipple's book stresses this and also the air of mystery that surrounds these minor members of the Solar System. He looks back in history, charting people's fear of comets, the solution of the orbit problem, and the mystery of the mechanism of the formation of the tail. He deals with the debate about cometary composition, the worries over their supposed retardation in interplanetary space and stresses the great gravel swarm—dirty snowball argument.

The book ends with the unsolved mysteries, how exotic is the ice, did comets bring life to our planet, what will spacecraft find out about Halley's comet and where do comets come from? It is profusely illustrated and I specially like the gallery of cometary characters—every one from Beirmann and Brandt to Urey and van Biesbroeck. Anyone with even the slightest interest in comets should read it and own it. ☐

Our garlicky neighbours overwhelm us

TELEVISION

Bernard Dixon

WHAT a hopeless shower we are! Here we slump, a declining power, imagining that the Chunnel is being dug to link us with nothing more edifying than a gang of peasants whose dreadful lives revolve around accordians, pissoirs and le striptease. That plus a political "system" which lurches continually from the comic to the chaotic. In fact, as writer/producer Tony Edwards and *Financial Times* frog-watcher David Marsh showed in **Hi-Tech à la Française** (Horizon, BBC2, 10 and 15 March), we are in for a kick up the nationals. What awaits us through the historic orifice is an army of human dynamos, educated up to their berets in science, who get everything right while we get everything wrong.

Determination and firm decisions were responsible, said *Horizon*, pointing out that France's R&D spending per head of population beats ours into a dented trilby. The results are legion. French golden delicious are delicious. The country's manufacturing industry has far outdistanced ours. Its telephones, the worst on the planet only 15 years ago, are now the most advanced, using digital technology invented but then discarded in Britain. We are now making pathetic attempts to catch up. It's the same with teletext: spectacular success in France, dismal disappointment (Prestel) here. Even if we do manage to pull ourselves together digitally, via System X, France will by then be bursting into the 21st century with videophones for all. Fifteen hundred have them already, free of charge.

Energy? Since the oil crisis of 1973, French engineers have built nuclear power stations at a world record rate, sensibly choosing the PWRs rejected by Britain. Over 30 plants now produce electricity cleanly and safely (not a single accident) and discharge less waste to sea than we do because French scientists have perfected the vitrification methods we failed to develop after once leading the world. And while France's recent savings in imported oil equal ours, it has achieved them by investing in the future rather than squandering North Sea resources today.

It is the same with weapons. French seabed missiles use French technology—unlike "Britain's" Polaris, which depends on the foreign sort. The Mirage is the most exported fighter in the world. France is Europe's leading arms manufacturer, with innumerable spin-off benefits. It also makes five types of helicopter, topping international sales. And Exocets, as we know, are devastating.

The story in space is more damning still. During the 1950s, when France was still learning, our boffins were putting Britain way ahead by working on Blue Streak. We then abandoned it, and today can only look on admiringly as Ariane wins glory for the republic. France is now building an Earth resources satellite that will surpass anything in Britain or even the US. Later this year following dithering impotence by the Brits, our garlicky neighbours will also show their spunk by putting aloft a European direct broadcasting satellite.

Wherever you look, more evidence piles up. Think of the 1100 industrial robots France makes each year—twice as many as here. There's 3D graphics software rivalling America's best. And the paperless, fraud-proof "smart card", way ahead of anything conceived in Britain and ready to conquer a vast global market, including the Japs. And an education system turning out technocrats all assured of well-paid careers in industry. And Eureka, France's plan for the technological renaissance of Europe. And the fastest train in the world (remember the APT!). And a contract to build and launch a communications satellite for the Arabs, signed recently in the face of American competition. And the fast breeder reactor now under construction. And golden delicious. And Exocets, which are very powerful.

I think I caught Mr Marsh saying the French were less overwhelming with computers, but I cannot be certain. I may have nodded off. Pull yourself together, Dixon. And for God's sake, pull yourself together Britain. ☐

This week's reviewers

Derek Ager is a professor of geology at University College, Swansea.
Martin Counihan lectures in physical science in the Adult Education Department, Southampton University.
David W. Hughes is a senior lecturer in astronomy and physics at Sheffield University
John Polkinghorne FRS is vicar of Blean and honorary professor of theoretical physics in Kent University
Andy Thomas writes for *New Scientist* on the interception of communications.

FORUM

The destructive sound of music

Strange noises have been coming out of the audio world lately. Barry Fox has his ear to the ground

AUDIO enthusiasts have been arguing for the past five years about the relative merits of digital and analogue sound. Now a professor of physics at a college in the US has come up with an extraordinary theory. Judith Reilly of Quinsigamond Community College in Worcester, Massachusetts, is warning the audio industry that digital recordings not only sound wrong, but that they cause physical damage to gramophones.

Peter Schrank

Even audio buffs who dislike the sound of digital recordings find it hard to take Reilly's ideas seriously. They think she may have misinterpreted the results of tests. But whatever the final judgement, she has helped to stimulate serious scientific debate on an issue which has so far centred on mumbo-jumbo and irrational anti-digital hysteria.

Reilly believes that any digital recording is blemished by spurious ultrasonic noise. This, she says, causes fatigue, headaches and nausea for the listener. The effect is the same regardless of whether the digital recording is released to the public on a digital compact disc (which carries the music to a laser player as digital pulses) or as an analogue vinyl LP (where the digital pulses have been converted back into a conventional waveform).

Some audio engineers will already be arguing with Reilly. The digital recording process relies on filters which cut off frequencies above 22 kilohertz, so the recordings should have no ultrasonic content. But let that pass. Reilly's ideas go much further, and get even more contentious.

The ultrasound coming from an LP based on a digital recording, she says, makes a gramophone turntable run irregularly. Prolonged playing of the record damages the turntable so that its speed becomes permanently irregular.

Reilly says she discovered the phenomenon five years ago, when she noticed that the music from LPs based on digital recordings sounded "smeared". To demonstrate that the effect was caused by fluctuations in playing speed, she put reflective strips on the turntable and measured their velocity with a phototachometer. After thousands of hours of measurements, on several hundred turntables, she concluded that just a few hours of playing digital music causes irrevocable fluctuations in the turntable's speed. Every record played on the turntable subsequently, whatever the source of the music, sounds smeared.

Reilly blames ultrasonic hash from the once-digitised music. The ultrasound, she argues, causes microcracks in the main bearing of the turntable. Thermal energy builds up around the cracks, and is released periodically, causing minute tremors which vary the speed of the turntable.

Linn, a firm in Scotland, makes arguably the best analogue turntables in the world. Engineers with the company have made no secret of their dislike of digital sound: they would not miss the chance of proving that digital technology is irreparably flawed. But engineers at Linn have been unable to reproduce Reilly's results, and describe her ideas as far-fetched.

John Atkinson, editor of *Hi Fi News and Record Review*, is publishing an editorial this week which throws Reilly's ideas open to public debate. Atkinson checked the speed of his own Linn turntable by playing a 3 kilohertz tone and using an electronic frequency counter to measure the output. Even though he has been playing digital albums for years, Atkinson found the variations in the speed of his turntable 10 times smaller than those measured by Reilly.

Atkinson has met Reilly and found her sincere. But he doubts her theories. "There has always been pitch instability on analogue turntables. Perhaps it was hearing the rock-steady pitch you get from digital compact discs which made Professor Reilly notice analogue instability. Then she looked for a cause and hit on digital-sourced LPs. She should try the tests again with a more accurate speed measurement than the phototachometer."

Julian Vereker's firm Naim, based in Salisbury, makes hi-fi amplifiers which are as widely respected as Linn turntables. Vereker discovered 16 years ago, when he first designed his amplifier, that ultrasound from LPs was a problem which audio engineers were wrong to ignore. His credo is that an amplifier should be able to cope with ultrasound, even though the listener cannot hear it.

A hi-fi cartridge, of the modern moving-coil type, will reproduce frequencies accurately up to 50 kilohertz, well above the audible range. Badly designed cartridges may produce resonant spikes up to 180 kilohertz. All gramophone records produce energy well outside the audible spectrum. It is caused by random surface noise, dust, dirt and the mechanical effect of the stylus tracking the vinyl groove.

Some hi-fi amplifiers can handle even the highest ultrasound frequencies, so that they reach the listener's ear. This can be subconsciously disturbing. Others sharply filter off everything above the audible range. The snag is that such sharp filters distort the audible sound. Vereker believes that the best compromise is to make an amplifier which is able to handle ultrasonic hash up to 50 kilohertz, and then roll off the rest with very gentle filters.

All this suggests that Reilly is completely off-beam in labelling ultrasound a new phenomenon which is the direct result of digital recording. Has she simply discovered an old phenomenon later than everyone else? Vereker thinks there may be a more subtle answer. By serendipity, his idea also explains why some people can listen happily only to "specially modified" digital systems and compact disc players.

Vereker's explanation hinges on the method of "error concealment" used in digital systems. With all digital recordings, whether on professional tapes used in studios or domestic compact discs, the electronics must compensate for gaps in the stream of musical data caused by blemishes in the recording medium. When these errors cannot be corrected, the system must conceal them. It does this by taking the last good digital word in the recording and reproducing a string of identical words. Then, when the errors have passed, the circuit starts reading words again. The result of this concealment is an artificial section of waveform, looking more like a sharp-edged pulse in morse code than the smooth curve of music. The unnatural sharp shape produces a nasty rough edge to music—and an equally nasty dose of ultrasound.

Scornfully, Vereker notes that anyone can make a compact disc player appear to sound better, simply by connecting it through a filter which removes the spurious high frequencies. Indeed, many of the modified compact disc players made by specialist firms have subtle extra filtering to make the sound "softer". At the same time, they remove some of the high frequencies inherent in the music.

As for Reilly's observations, Vereker points out that, when a gramophone turntable rotates, the drag of the stylus in the vinyl groove inevitably changes with the music, because the undulations in the wall of the groove are changing. If the turntable has a weak motor, its speed will fluctuate with the music, affecting the sound. Suppose, says Vereker, that the music from an LP based on a digital recording has been distorted by error concealment before it was transferred to the LP disc. This is quite likely. The unnatural edges in the waveform will be there in the groove to put an extra and erratic drag on the stylus. This would neatly explain Reilly's observation that LPs based on digital recordings cause the speed of the turntable to vary.

One question remains unanswered. Is Reilly right in saying that digital sound causes *permanent* damage by creating cracks in the bearing of the turntable? So far, there are no takers on this one. □

A toast to absent friends

Colin Tudge hankers for the return of *Australopithecus robustus*

A PARTY GAME for Easter: draw up a shortlist of long-gone creatures that might be brought back to life, with the aid of some beneficent time machine. Mine would include some that should not have gone extinct; ones that I still feel slightly absurdly angry about. The dodo should be there, amiable mega-pigeon from Mauritius, with its close relatives from Rodrigues. By all accounts it wasn't simply over-exploited, or pushed aside by dogs and goats, but assiduously hounded to death.

The great ratite moas should come back too. There were at least 15 kinds when the Maoris arrived in New Zealand in the 10th century AD, but by the middle of the 19th century there were none. Just as our present Prime Minister has forever buried the myth that a woman would necessarily govern with a gentle hand, so the Maoris have shattered the notion that pre-technological people inevitably live in harmony with their fellow creatures. They wiped out the biggest land animals in their territory.

I suppose it really is too late to feel angry about the elephants of Europe and North America that were helped on their way by our ancestors—but mammoths almost made it into modern times, and the tundra would be a richer and a wilder place if they could just have hung on. Sabre-tooth cats, too, were an alternative form that once was extremely successful and varied, and they ought to have survived. So too should the deinotheriums, great elephants with downturned tusks in the lower jaw, and the three-toed horses that galloped across the same Laetoli mudflat as the pre-humans who left their footprints more than three million years ago.

Just to be flashy, and going much further back in time to about 30 million years ago, we should reinvoke *Baluchitherium*, a giant hornless rhinoceros, 5 metres at the shoulder and weighing about 16 tonnes—probably the biggest land mammal of all time. But I don't think I would bring back any of the dinosaurs, on aesthetic grounds. Their world has gone; they would not be at home in the age of angiosperms, and anyway a tyrannosaur just shouldn't be seen eating a sheep.

But there's one creature whose resurrection would be on the one hand wonderful, and on the other mischievous. If it had lived it would be our closest relative. It is called *Australopithecus robustus*.

The australopithecines first appeared in Africa about four million years ago. Different palaeontologists interpret the fossil evidence in different ways, but a fairly orthodox version of their subsequent fate runs roughly as follows. The first kinds were similar to Don Johanson's Lucy, which he places in the species *Australopithecus afarensis*. *A. afarensis* graded eventually into *A. africanus*, which was the first australopithecine species to be described and named—by Raymond Dart in the 1920s. *A. africanus* developed in two directions. The slimmer, or "gracile", kinds became brainier as time passed, and about 2·4 million years ago they gave rise to the first of the genus *Homo*. This was *H. habilis*, who begat *H. erectus*, who eventuary begat *H. sapiens*, ourselves. But other members of the species *A.africanus* became heavier with passing generations—and it was they who gave rise to robustus.

A. robustus. *A useful chap to have around*

BMNH

While the jaws of early *Homo* became smaller, tucked in beneath the face, those of robustus took on the aspect of a man-trap. *Homo* developed the kind of teeth that we have: blade-like incisors and canines, modest premolars, and passable, though not impressive, molars. With such teeth they would have eaten as we do: a catholic diet with at least some meat that they must have prepared with tools or fire. The teeth of robustus were altogether more workmanlike: solid rows of quern-like cheek teeth, the premolars as solid as the truly remarkable molars. Robust australopithecines indeed were fearsome, but with the fearsomeness of the gorilla: they almost undoubtedly were vegetarians, eating leaves and fruit.

Robustus was not inferior to *Homo*. As Elizabeth Vrba, now at Yale, points out, both creatures were simply adapting in different ways to the shifting environment of Africa, and in particular to the increasing desiccation between three million and two million years ago. *Homo* thought his way out of trouble, she says, while robustus chewed his way out of it.

For a long time, too, the robusts were successful. Indeed they survived for more than a million years, and died out only about 800 000 years ago. But the parallel with gorillas is not quite apt. Gorillas are above predation, while the robusts clearly were not. Indeed, Bob Brain, director of the Transvaal Museum at Pretoria, has found hundreds of robustus skulls in the limestone caves at Swartkrans. Most, if not all of them, show signs of attack by carnivores, sometimes by sabre-tooths but generally by leopards.

Indeed, Brain feels that leopards probably helped to drive robustus to extinction. Today, leopards terrorise baboons: they find out where they spend their nights, and simply lie in wait. Perhaps they did the same to robustus, waiting by the caves in the cold winter nights for their supper to turn up. The caves contain very few *Homo* skulls. Perhaps our own ancestors were too bright to fall for the same old ambush season after season; but perhaps when the robusts were clobbered once, they faithfully returned to be clobbered again.

But if the robust australopithecines were resurrected, or if they had pulled through as they very nearly must have done, what would their status be now? If they had lived till the birth of the firearm, they would probably have been hunted to extinction like many an aboriginal in several continents. If they had survived that, then biologists would not have been slow to realise that as the closest relatives of humankind, with a physiology much the same but intriguingly different, they were also the ideal "model" for us. Would they be dragged from the wild then, or raised on farms, to be filled to the eyeballs with candidate vaccines? And how would they have fared under apartheid? Would they have a reserve to themselves, and hang around the hotels, like the bears in Yellowstone? Or would they qualify for an independent state, an australopithecine Bophuthatswana?

Taken all in all, it's probably just as well that the leopards got to them first. □

Calling all Branestawms

Roger Milne has news of a new wheeze for amateur inventors

SMALL is beautiful, preach disciples of Schumacher. Socially useful work is good for you, exhort a handful of trades unionists, keen that major industries should stop producing weapons and dubious consumer goods and embark instead on projects aimed at reducing pollution or helping the developing world.

Such Utopian ideas may not, at first glance, fit the image of Britain's market-orientated and thrusting enterprise culture so beloved of our current political leaders. Still, necessity can make strange bedfellows.

Consider the following. A couple of weeks ago, representatives of some of Britain's biggest companies, together with one of our largest water authorities, turned up in London to pick up awards offered under a unique British scheme: the Pollution Abatement Technology Award. Government ministers, no less, applauded as people from the companies concerned—Boots the chemist, ICI, Castrol, Rolls-Royce and the Severn Trent Regional Water Authority—collected their wooden trophies, fashioned out of Makasar ebony and sycamore.

The scheme has been going for three years now, though it is unlikely to remain unique for much longer. With European Environment Year looming in 1987, Brussels is about to snaffle the idea.

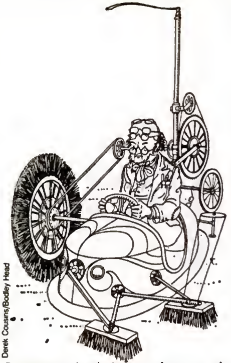
That isn't the only new development. Next year, barring a disaster, the ceremony will not be confined to household names. For the first time, the organisers are actively seeking individuals, students and schools who can come up with that elusive ideal: an innovative idea that can be turned into a commercial product. Up to now, the scheme has concentrated on technology that has got beyond the drawing board, and which candidates intended to develop or market themselves. Now the scheme is being broadened to include a second category, known as Ideas for Industry. The aim is to draw out environmentally useful suggestions which might be taken up by others. An opportunity, in other words, for Professor Branestawms, or the person working in the Anderson shelter, or Form 3b in Portakabin 5, to come up with a world-shaking invention.

As the title of the award makes clear, the scheme sets out "to identify, encourage and publicise innovations in technology to abate pollution of all kinds". Over the past three years, equipment designed to combat hunger, poverty and pollution in the Third World has figured prominently in the 160 entries considered. One of last year's winners was Potopak, a "low-technology" method of providing clean water in small communities. It owed its genesis to the water purification systems pioneered by the Victorians, who used sand to filter drinking supplies. So far, Potopak kits have been sold in the Yemen Arab Republic and Nepal, and orders are coming in from Honduras and Peru. A version using a solar-powered pump is now in the pipeline.

Closer to home, the problems tackled have covered many of the 20th century's most immediate concerns—acid waters left after mineral extraction, aircraft noise, asbestos, bacterial fouling, cyanide, drifting crop spray, municipal waste tips, oil spills, organic wastes such as paper pulp and potato residue, paint solvents, pectin effluent, sludge from sewage and waterworks, and water sanitation. The most recent crop of entries underlined current interest in ways of curbing air pollution, with ideas for low-emission diesel engines, lean burn engines, and a scrubber system to stop discharges of iodine from chemical works.

Curiously, there have been some intriguing gaps in the sort of project entered. Very little on the recycling front, for instance, and nothing of any consequence in terms of suggesting alternatives for toxic nasties such as asbestos. Having said that, asbestos did feature last year, when one of the winners was Vitrifix Ltd, with a scheme for converting any kind of asbestos into an inert glass. The process is being used at the Trident submarine base at Faslane, on the west coast of Scotland, where the discovery of land contaminated with asbestos had held up development.

Entries for the 1986 award have to be in by June. Don't write to us. Details are available from the Royal Society of Arts in John Adam Street, London WC2N 6EZ. The society, together with the Confederation of British Industry and the Department of the Environment, act as the promoters. The scheme is sponsored by the Environment Foundation. □



Derek Cousins/Bodley Head

Branestawms's device to clean up the streets. Similar ideas would be welcome

What's in an A-level?

A plea for a broader view, from Robin Dunbar

A RECENT STUDY by Kingston Polytechnic's School of Economics and Politics has revealed that students with an A-level in economics get lower degrees in the subject than those who took other A-levels. One suggested explanation for this disquieting result is that A-level economics is considered to be a soft option, so attracting students of below average ability.

But there is another explanation which has implications far beyond the narrow confines of economics: early specialisation is counterproductive. The results from Kingston prompt us to ask whether science A-levels might not also be a disadvantage for science degrees. Far from promoting deeper study, they might serve only to reinforce the narrow focus of one particular discipline at the expense of a broader view.

Educationalists have been worried about this over-specialisation for some time, of course (see "A broader base for schools", *New Scientist*, 6 February. p 65). It is often seen as no more than the "illiterate scientist" syndrome. But there is more to this than improving scientists' literary skills. Success in science depends on seeing new patterns and relationships. And the ability to see novel patterns itself depends on a breadth of experience that allows analogies to be drawn between intellectually distant disciplines.

Even a cursory glance at the history of science shows how important unprejudiced minds are when it comes to developing new concepts. Take Antoine Lavoisier, who, in 1777, published a paper that established the basis for our modern atomic theory of chemistry, thereby unifying what had until then been the two unrelated fields of physics and chemistry. But Lavoisier himself was neither a chemist nor a physicist: he was a lawyer by training and a businessman by trade.

As director of the French government's arsenal, Lavoisier's job was to ensure the production of gunpowder for the armed forces. It was during an attempt to improve production techniques that he came up with his new theory of the nature of chemical reactions. What gave him the insight that escaped professional chemists of the stature of our own Joseph Priestley was his early training as an accountant in the

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Robin Dunbar is a research fellow in the zoology department at the University of Liverpool.

French tax service. When you add and subtract quantities in a ledger, the columns have to balance, he suggested. So why shouldn't they also have to balance in chemical reactions?

Another example with chemical associations concerns Louis Pasteur, creator of the modern theory of microbiological processes and France's greatest biologist. Pasteur was no biologist: in fact, he held the Chair of Chemistry at Strasbourg University. The turning point came when he was asked by the brewers of Lille to sort out a problem they were having fermenting beer. At that time, fermentation was thought to be a simple chemical reaction. Pasteur's genius lay in realising that it was a *biological* process. That discovery revolutionised not only the brewing industry, but also biology and medicine.

These two examples are far from unique. What they underline, however, is that it is not necessarily the experts in the field who make the significant discoveries. This also explains why most scientists make their major contributions to knowledge during their earlier years. Later on, their minds are too encumbered with preconceived ideas.

Which brings us back to A-levels. Someone with good A-level grades should be able to turn his or her mind to almost anything. Apart, perhaps, from a grounding in mathematics, there is no intrinsic reason why an A-level in English literature should not lead on to a degree in physics.

It always used to be said that a first degree was no more than a training in how to think. Now, we increasingly seem to assume that a degree confers knowledge. Nothing could be further from the truth. The civil service, for example, used to prefer classics graduates. Classics has the distinct merit that it can be of no possible relevance to the modern world and so cannot cloud a civil servant's judgement with theories that once excited passing interest during an undergraduate episode many years before.

There remain two major obstacles to any freedom of movement between disciplines: the universities and the employers. For reasons that have always escaped me, the former tend to insist on evidence of specialised abilities for their entrance requirements. They might do better not to. Because competition for university places is often more severe for arts courses than for science courses, entrance requirements for arts courses are commonly significantly higher. Perhaps British science would benefit by poaching some of these brighter arts students, despite their "irrelevant" qualifications.

But the ultimate problem remains the employers, partly because they provide most of the jobs for graduates. Unfortunately, most employers seem to suffer from an even greater block against lateral thinking. Of course, it makes their selection procedures easier if they have to look only for the candidates with the right key words on their applications. But in doing so they run the risk of saddling themselves with the merely competent. A little imagination might allow them to take on those with the greatest potential, even though they might not have exactly the right piece of paper. ☐

A pedigree champion for science

A new voice makes itself heard at Westminster

THISTLE DIARY

Tam Dalyell MP

"THERE is a very real role for the government to play in helping to seek out opportunities and give a lead by showing industry that they are serious about funding a major science budget to assist industry."

Those words come from a Conservative MP, in a maiden speech to the Commons. The MP goes on:

"I fear that unless we tackle this problem, we shall begin to lose out in the highly competitive scientific and technological drive that is fuelling, and will continue to fuel, the prosperity of other more successful nations. For my part, I see little distinction in a nation that professes to wish to compete in the international, commercial and industrial markets of the world, but which is so miserly with its science budget that effectively it cuts off its nose to spite its face.

"We have the opportunity to create, as partners with industry, the kind of heady atmosphere that senses and feels the possibilities, the opportunities, and the vastly increased potential of high-tech world-wide markets. A critical factor in achieving such confidence is the working together of government, scientists and industry. They [the government] appear to believe that national strength in basic research is not essential for economic success."

The MP speaking? None other than Sir Winston Churchill's other and infinitely more intelligent grandson, Nicholas Soames, MP for Crawley.

Nicholas's father, Christopher Soames, who was Macmillan's minister of agriculture when I was first elected, was tipped as a future Prime Minister. He was defeated in Bedford and became a highly successful commissioner in the European Economic Community.

Nicholas Soames is a man who matters in the Conservative Party, and not just for reasons of political pedigree. The fact that he devoted his first speech to a forthright confrontation with his own ministers suggests that ministers will have to take science more seriously.

* * *

"A SMALL 'forerunner' barrage scheme in one estuary will tell us little about the detailed implications of a larger one in another estuary," asserts a civil engineer, who writes to me in response to my comments on the Mersey barrage scheme (13 February, p 57). "Studies unique to each site must form the main element in planning any scheme," he adds.

I must accept that I was wrong on this issue, and will therefore quote further from the letter.

"If we needed a 'forerunner' to teach us all that has to be learned by site experience about plant design and operation (a large barrage simply has more units of a similar size), the Rance Barrage in Brittany has done this abundantly well for nearly 20 years, since November 1966.

"At a time of high unemployment, it is alarming to note that you advocate relatively small and occasional capital works. The Severn Barrage scheme, recommended in 1981 by a highly competent and representative committee set up by your own party, could create over 10 times the number of jobs. Furthermore, this scheme is not large by the scale of power station construction required in the UK from about 1990/95 onwards, ie, spending on major capital works will soon be unavoidable."

My correspondent regards it as irresponsible on my part to be advocating a trifling policy for an issue of such import, "especially when we now know that major tidal power schemes offer the UK cheaper electricity than is available from any other source. Why are we seemingly incapable of accepting and hence benefiting from such commercially obvious facts?"

* * *

WHAT, I ask, is the government's attitude towards the directive from Brussels banning the use of hormones as growth promoters in animals?

Michael Jopling, minister of state for agriculture, fisheries and food, tells me that the government is applying to the European Court of Justice to seek annulment of the directive. "This action reflects our objections to the basis upon which this directive was adopted, including the lack of regard for relevant scientific evidence," he says.

ARE HORMONES IN MEAT DANGEROUS?
NOT A BIT, MADAM.

Jopling adds that, in taking this action, the government does not seek to discourage producers who want to rear animals without the use of added hormones. Until a ban is implemented, this remains a matter for individual farmers.

* * *

PETER CERESOLE, of London, adds fuel to the debate about anti-misting kerosene (AMK):

"This autumn I made a programme about survivability in aircraft accidents for *Panorama*. In it we discussed the potential of AMK in accidents like that at ▸

▸ Manchester. We filmed at the Federal Aviation Authority's (FAA's) test centre at Atlantic City, where they have recently carried out a series of full scale controlled tests. These confirm that, even when an AMK fire *can* be induced, and sustained in a fast moving airstream by some source of flame such as hot engine parts, the temperature rise on any surface on which it impinges is much less than for the same fire with unmodified kerosene. The effect is believed to be caused by the coating of the fuselage by the unburnt portion of long stringy AMK molecules, which then cool the skin by evaporation in the flame.

"I discussed precisely the problem your correspondent raises [the tendency of the fuel to "gel" (Thistle Diary, 23 January, p 65)] with Bill Westfield, the leader of the FAA's AMK programme. They have been operating modified engines and aircraft for some years now, and he told me that although at present they use a conventional engine fuel system with the addition of "degraders" to cut the long chain molecules before combustion, an operational system would incorporate the degraders into the fuel pumps themselves. The existing design of fuel pumps lends itself to this, and Westfield maintained that, from their experience there should be no engineering or safety problems from this source.

"The greatest potential problems that he foresaw were operational—the correct fuelling of the aircraft, where the mixing of the AMK has to be done at a late stage. But these are not engineering, but procedural problems. He believed that the potential benefits far outweighed the potential risks." □

ENIGMA

No 351

Four flies

by Stephen Ainley

FOUR UNFRIENDLY flies are sitting watching the cricket. Each is on the boundary of the ground, which is perfectly circular. Their names, in order round the edge, are At, Bet, Cot and Dut.

The length of each of the straight lines At-Bet, Bet-Cot, Cot-Dut and Dut-At is an exact whole number of flymins (that is, the flies' unit of distance). Two of those lines actually have the same length. Furthermore, the total of these four lengths is precisely the same number as the area (in square flymins) of the quadrilateral At-Bet-Cot-Dut.

If I tell you that that area does not include the pitch (which is at the centre of the ground), can you tell me the four lengths?

A £10 book token will be awarded to the sender of the first correct solution opened on Thursday, 3 April 1986. Please send entries to Enigma No 351, New Scientist, Commonwealth House, 1-19 New Oxford Street, London WC1A 1NG. The Editor's decision is final. The winner of Enigma No 348, "A piece of cake", was Lindsay Nicholson, of London.

Answer to Enigma 348

A piece of cake

Two people, six people, 41 people (not counting me).

FEEDBACK

GIOTTO lives, although its dust-shield is shot to pieces. However, the coma of Halley's comet is not the most dangerous place in the Universe. We learnt last week that a full-size replica of Giotto nearly came to grief in the studio of *Tomorrow's World*. Scene shifters managed to damage the model's dust-shield in a way that uncannily resembled what happened to the real thing. The poor old Beeb had to pay the University of Kent £4000 for repairs. □

ANOTHER BLUNDER nearly spared us the embarrassing sight of James Burke and Patrick Moore desperately trying to say something about the pictures that Giotto sent during the encounter.

Last summer, the French national broadcasting authority nearly did an exclusive deal to sell pictures to its opposite number in Japan. It was on the verge of signing the agreement when someone in the European Space Agency realised it was a bad idea for European broadcasters to receive their information about Giotto from a public relations agency in Japan. □

AS USUAL, we asked Ladbrokes about the odds of Giotto surviving the encounter. The reply: "We never give odds when lives are at stake". Perhaps it's a mercy that someone had not had a surfeit of information about the comet. Or perhaps he was talking about what would have happened to Patrick Moore if the event had failed utterly. □

AFTER the giggles, the message. Giotto worked because of a remarkable example of international cooperation. The stars: Dr Roald Sagdeev, of the Soviet Union, for admitting to being too superstitious to schedule new targets for the Vega craft before the encounter; Carl Sagan for praising the Russians for giving him so much freedom in Moscow; and of course Ireland's Susan McKenna-Lawlor for reminding us how enthralling science is supposed to be. □

"EVERY TIME I use the gents here I think it is about time they modernised the place." The comment, from Bas Pease FRS, was about the facilities at the Royal Society.

Pease's concern is not so much about the hygiene of his fellow fellows, but about the message that stares at everyone who uses the urinals. "ZETA" it says at the top of each one. ZETA, of course, was the name of a fusion research machine that caused so much of a stir a quarter of a century ago. Not only is Pease now the head of Britain's fusion programme, he was one of the scientists who worked on that ill-fated machine whose initial "breakthrough" turned out to be less startling than it seemed.

Fusion scientists have been trying to live down the episode ever since. It cannot help to be reminded of it every time you go for a Jimmy. □

IT ALL STARTED with an advertisement in the *Middle East Times*. "England's Heritage—For Sale", it said. Someone in Nicosia, Cyprus, was selling "genuine English red cast-iron telephone boxes". The boxes, says the ad, are not only a "unique conversation piece" but "can be used also as a shower, swimming pool changing room, greenhouse or aviary". The advertisement does not mention their more usual function as public lavatories.

It all seemed too good to be true so we called British Telecom. Yes, said head office, phone boxes are available from time to time, ask at your local general managers' office. We did. The boxes cost "between £200 and £400, depending on the condition".

"By the way, they weigh three quarters of a tonne—and the buyer collects." □

BRITISH TELECOM *is* on the ball, these days. So far as we know, it has been the first organisation to write to us under the terms of the Data Protection Act, asking our permission to include our name and address in its computerised mailing list.

Sensibly, it asks people to reply only if they *do not* want to be on the list. Feedback awaits a similar request from the people who send mail-order catalogues. □

ANYONE who was hoping that the Kendrew Committee's report into physics might put paid to particle physics in Britain can take heart. One senior particle physicist seems to have thrown a switch that is about to make the whole business self-destruct.

This physicist suggested to someone with fiscal powers that the subsistance rates for working at CERN in Geneva might be substantially reduced.

Now, technicians who leave their homes and hobbies to work unsocial hours putting experiments together at CERN have been told that their subsistance rate is to be cut by about 40 per cent to a bare minimum—a mere 65 Swiss Francs per day for eating, which is hardly enough to buy a decent meal in Geneva.

The physicists have also been given the new reduced rate, and this will hurt their pockets even more, as they were generally on a higher rate than technicians. About time too, you might say: the physicists do the work for the glory of the knowledge they gain.

The only trouble is that they may have a lot more work to do. Some technicians have already asked to be moved to other kinds of research. Soon there may be only one happy senior physicist left (guess who) and a few overworked colleagues wandering round asking "Anyone know how a soldering iron works?" □

THE ANSWER to "Where's the beef?" is that it is in the can. A firm in Britain advertises its products as containing "over 100 per cent meat".

One cynical soul complained to the Advertising Standards Authority. To no avail. The meat is cooked before it is canned, and Britain's food labelling regulations lay down that the meat content is calculated before it has shrunk through cooking.

Now own up: you didn't know there was so much in a tin, did you? □

LETTERS

Differentials

Your mischievous suggestion that different pay rates should be imposed on civil servants doing jobs of equivalent responsibility to make them see sense in the teachers pay claim (13 February, p 12) caused smiles among specialist inspectors working for the Health and Safety Executive (HSE).

Specialist inspectors in the Technology and Air Pollution Division of the HSE cover a wide range of disciplines including electrical, mechanical and civil engineering, physics, chemistry and microbiology. We give guidance and advice to industry, to the enforcement inspectorates such as HM Factories Inspectorate and to national and international bodies such as the British Standards Institution.

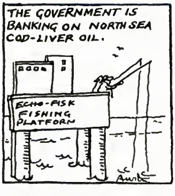
We have been negotiating for 12 years for a common grading system throughout the HSE so that equal responsibility gets equal pay. At the moment specialist inspectors working alongside their colleagues who are administrators, factory inspectors, nuclear inspectors or air pollution inspectors with equivalent responsibilities may get £2000 less pay than them. The editorial was right when it said this was a "recipe for resentment and declining morale". The increasing number of specialists who are leaving the HSE and the impossibility of recruiting properly qualified replacements amply demonstrate the fact.

The intransigence of the Treasury, which thinks only of levelling pay downwards, has blocked all the efforts of unions and management to achieve an equitable solution.

Name and address supplied

Dead platforms

Your article "Death of an oil platform" (27 February, p 36) is very good, but let me add an interesting point or two. Forty metres may be too deep to support algal life but general fish life round wrecks or platforms is prolific at much greater depths than that.


THE GOVERNMENT IS BANKING ON NORTH SEA COD-LIVER OIL.
BOOO!
ECHO-FISK FISHING PLATFORM
Austin

Forty metres is by no means too deep for hook-and-line fishing, thousands of commercial boats hook fish much deeper than that in Europe and Scandinavia alone.

You can rest assured that all structures in the North Sea concentrate fish in very large amounts with little apparent seasonal variation barring spawning migrations. The same goes for wrecks which are the basis for a major commercial fishery prosecuted by the Danes with special gill nets and hauling equipment.

For the past few years, the Japanese have purpose-built large fish-aggregating structures in order to restock their somewhat denuded coastal stocks.

Ask any trawlerman or seine netter working the North Sea whether rigs concentrate fish and they will assure you they do despite laws about vessel proximity to rigs when fishing. They know quite well what the situation is.

The attitude of fishermen towards oil debris is much coloured by the fact that it is widely scattered in small amounts and uncharted. This causes huge problems. Rigs themselves being of known location do not offer the same unexpected problems as casually discarded or lost debris.

Provided guarantees of so called tidy demolition locations are given and upheld, objections of the fishing lobby might be much reduced.

Incidentally, it is not hard to fix underwater multifrequency sonar warning beacons to discarded rigs and piplines in order to warn marines and fishing vessels. Our firm already makes such gadgets.

R. J. Wout
Scanmar As
Wickambreaux, Kent

Embryo research

I read with interest Mike Rayner's article "Experiments on embryos: stick to the facts" (Forum, 27 February, p 54). Indeed, would that he had.

It is incorrect to infer that the organisation called Progress was against a statutory licensing authority. Those responsible for launching Progress agree, as do all the members of our licensing authority, that this is the objective to which we all should aim. Pending such legislation they fully support our efforts.

The 32 centres doing both clinical and research work for *in-vitro* fertilisation have applied to us for approval. The results of their applications will be found in our first annual report to be published at the end of April.

Any centre undertaking research has first to state its objectives to its own ethical committee, this is then followed by a visit from one of our teams. The investigating team reports its findings to the whole authority for discussion before the granting of any licence to undertake the research in question.

Another correction is that following the recommendations of the Warnock report, we have a lay chairman, and half the members of the authority are lay.

I believe that our authority is the only national body which has been able to obtain a complete picture of this work in its own country, though Australia is working towards this.

Mary Donaldson
Chairman
Voluntary Licensing Authority
for In-vitro Fertilisation and
Human Embryology
London

Carbon dating

We were surprised to see the news item "Dating service criticised for inefficiency" (This Week, 20 February, p 19) in which this laboratory is apparently "criticised" in the review of science-based archaeology by the Science and Engineering Research Council. Your reading has been so selective that we are bound to see it as deliberate distortion.

For example, the report also says: "... the work [of the Oxford C14 accelerator dating facility] is of the highest technological and scientific merit ..."; "... its reputation within the C14 community is very high ..."; "... it has already made a substantial impact on archaeology in the UK ..."; "... the Oxford facility is comparable in performance with other C14 accelerators in the world at present ...".

It is true that the report offers some criticism of the comparatively small number of dates per year achieved. However, in the past year we dated more samples (400) than the laboratory with which we are compared (Arizona), and we have published more dates than all the radiocarbon accelerator laboratories put together.

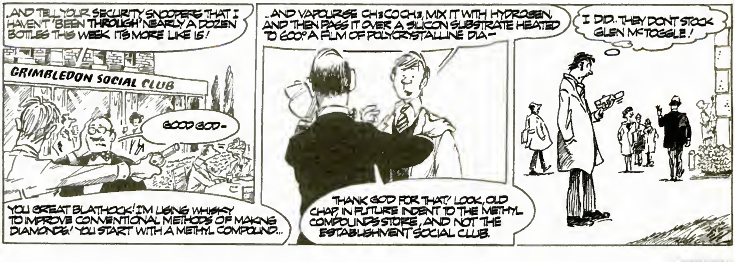
Moreover, where the report states that the Arizona chemistry techniques are superior to Oxford, in fact, the senior sample preparation chemist at Arizona for the past 18 months, actually came from Oxford where he had spent four years developing these methods.

Given the amount of public money spent on what is generally thought to be exciting and successful research and an important archaeological tool, we think you should show some responsibility to get most of your facts right.

Edward Hall, Robert Hedges
Research Laboratory for
Archaeology and History of Art
Oxford University

GRIMBLEDON DOWN

Bill Tidy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I DID.. THEY DONT STOCK GLEN McTOGGLE!

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7B61

Open sewer

When reading your recent editorial on British Nuclear Fuels' operations at Sellafield (27 February, p 12), I had to check the cover to make sure it was *New Scientist* and not the *Daily Mail* that I was reading. So this "open sewer" should be shut with a "stroke of a pen", should it?

Perhaps, as scientifically minded people, we should try to put some figures to this "catalogue of leaks, contaminations and pollutions". We might find that, as a result of these accidents, environmental radioactivity has increased by one part per million per year. In other words, in one hundred thousand years this kind of pollution would have increased by 10 per cent. A truly horrific prospect, especially when considering how few people will die during that time from causes other than background radiation.

You quote the requirement by the International Commission on Radiological Protection that "exposure to radiation be kept to minimum". How would you define a minimum—a hundred times less than now? Would you be satisfied with a million-fold reduction? I think not, because this frame of mind does not recognise any level of pollution as acceptable. A kind of industrial zero option.

What kind of a scientist, new or old, is in favour of that?

The Sellafield reprocessing plant has *not* been designed to withstand a direct hit by a 50 megaton bomb. An engineer, who has now retired to work for Friends of the Earth, warned about this as long as 20 years ago, but was completely ignored by the incompetent pro-nuclear establishment.

Vladimir Sik
Exeter
Devon

THE LATEST LEAK HAS BEEN TRACED TO SOME CORNISH PASTIES IN THE CANTEEN
BNFL SELLAFIELD PRESS RELEASE
Austin

* * *

In response to your editorial "Shut this open sewer" and the hypothesis that there is no safe level of radiation exposure, can I also suggest a mass evacuation of the Cornish population?

According to the recent survey by the National Radiological Protection Board, there must be thousands of men, women and children who receive every two months, from radon gas in their homes, the maximum permissible annual dose for radiation workers.

R. Webster
Halkirk
Caithness

Dead Digit

"Diane Fossey was killed by poachers. Digit may die from a human virus" (This Week, 27 February, p 20). No. *Dian* Fossey was killed by poachers. Digit died at poachers' hands in February 1978. The death of Digit and the subsequent killings of further gorillas from Diane Fossey's study groups, drew attention to the plight of the mountain gorillas. This initiated many fund raising campaigns and projects for the protection of mountain gorillas and Diane Fossey's momentous personal campaign against poaching—a campaign which led to her untimely death.

Gavin Dawe
Penicuik
Midlothian

Wine oh!

We should all rejoice in the reassurances given by a wine shop manager when I declined some Austrian wine, just in case it contained antifreeze. "Oh dear," he said, with knowing superiority. "It's a pity you don't know any chemistry. Let me show you. This is the formula for alcohol and this is the one for ethylene glycol. Now you can see there is hardly any difference and there is certainly nothing poisonous present. Both are simply combinations of carbon, hydrogen and oxygen, nothing more. All that nasty publicity put out by other producers is very wicked indeed!"

Tony Greenfield
Letchworth
Hertfordshire

Right royal verbiage

Tom Bell, in his first-rate article "Breaking the language barrier," laments the lack of response to the Royal Society's plea for better coverage of science in the mass media (Forum, 27 February, p 55). If the one example of the society's output which I own is typical, then I don't wonder that journalists haven't responded.

I took *New Scientist's* tip and obtained a free copy of *Science is for Everybody*, which was said to be a simplified version of the society's report, *The Public Understanding of Science*. What a letdown. Such a deadweight of stodgy "wordiness". One sentence in particular stands out. I won't quote it, it's 109 words long and studded with no less than eight parentheses.

This kind of verbiage shouldn't be inflicted on anyone. In a plea for a wider dissemination of science it's ridiculous.

Colin Wagstaff
Woodlesford
Leeds

We welcome short communications and reserve the right to edit the longer ones. Write to: Letters to the Editor, *New Scientist*, Commonwealth House, 1-19 New Oxford St, London WC1A 1NG. Or send to Telecom Gold Box 83: NSM005.

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AGRICULTURAL AND FOOD RESEARCH COUNCIL

Institute of Food Research–Norwich Laboratory

POSTDOCTORAL POSITION THEORETICAL CHEMIST/APPLIED MATHEMATICIAN

As a result of a New Initiative, the Institute has a postdoctoral fellowship tenable for three years from October 1986, to begin an area of research into the effects of diffusive exchange on NMR relaxation in heterogeneous and biological systems. The work will involve the development of appropriate models at the phenomenological level as well as examinations of the effects of exchange on the spectral density functions. It is expected that numerical solution of the expressions derived will form a significant part of the research activity. The successful candidate will join an active and expanding group with a diversity of interests in both practical and theoretical aspects of spectroscopy.

Qualifications: A first or upper second class honours degree in physics or chemistry and a PhD. Experience in the application of quantum mechanics or NMR theory is essential.

Appointment will be made at the Higher Scientific Officer level and will be for a maximum of three years.

Salary scale: £7788-£10 541 pa. Non-contributory superannuation scheme.

Further details and application form from the Secretary, Mr V. H. Standley, Institute of Food Research, Norwich Laboratory, Colney Lane, Norwich NR4 7UA, quoting Reference 86/NI/3.

Closing date: 3 April, 1986.

NATURE CONSERVANCY COUNCIL

HIGHER SCIENTIFIC OFFICER

Mountain Plateau Ecology

Applications are invited for the above post to evaluate impact of disturbance on vegetation and fauna; to determine associations between soils, vegetation, invertebrates and breeding birds; and to reveal ecological processes. Duties will include organising a programme of research; recruiting and supervising fieldworkers; and analysing data for publication.

The post is based at Edinburgh under the supervision of the senior upland ecologist in the Chief Scientist Directorate, and will last for three years in the first instance, with a possibility of extension up to a maximum of five years.

Qualifications: The successful candidate should possess a good honours degree or equivalent in a biological or related subject and at least two years reasearch experience. Familiarity with upland birds and vegetation would be advantageous, as would abilities to design field experiments, analyse large data sets and write clearly for publication. Physical fitness, an ability to work in difficult conditions and a current driving licence are essential.

Salary: Depending upon qualifications and experience, starting salary will be within the range £7788 to £10 541.

Application forms and further details are available from Personnel 1, Nature Conservancy Council, Northminster House, Peterborough PE1 1UA.

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Please write or telephone for an application form to: The Personnel Officer (RTC), Glaxochem Limited, North Lonsdale Road, Ulverston, Cumbria LA12 9DR. Tel: Ulverston (0229) 52261 Ext. 121.

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MORE VACANCIES ON PAGES 2–17

United Kingdom Atomic Energy Authority

Engineering Sciences & Thermal Hydraulics

The Harwell Research Laboratory is seeking to recruit people able to take a leading role in research into fluid mechanics, heat transfer and separation processes for the offshore, nuclear and processing industries. Appropriate candidates are likely to have had a minimum of 3 years' post-graduate experience or hold post-graduate qualifications.

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Harwell, located in Oxfordshire, is the main research laboratory of the United Kingdom Atomic Energy Authority and is also the largest contract research laboratory in Europe. The research programme spans a wide range of science and engineering, with an emphasis on obtaining results for customers. Starting salaries will be up to £13,540 p.a. according to age, quality and experience. There are excellent opportunities for subsequent career advancement. Relocation assistance may be available.

For further information and an application form please write to Miss S Scott, Recruitment Branch, Harwell Laboratory, Didcot, Oxon. OX11 0RA or telephone (0235) 24141 ext 3169 (or 24-hour answering machine on ext 2614). Alternatively dial 100 and ask for Freephone 3644.

Please quote reference number NS/1798 in all communications.

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Further details of the work of the Microbiological Department may be obtained from the Secretary FMBRA, Chorleywood, Herts WD3 5SH. Applications giving details of education and career to date should be sent to the Secretary at this address.

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Salary scale: £8712-£10 257 inclusive.

CHEMISTRY TECHNICIAN GRADE 4

Applications are invited for a Grade 4 Chemistry Technician to work in the instrumental, research and teaching laboratories of the School of Chemistry. Experience in the organisation and maintenance of laboratories for undergraduate and project work is essential; evidence of previous work with instrumental equipment such as an elemental analyser and spectroscopic techniques will be an added advantage. Applicants should possess an OND, ONC, B Tech/Tech Certificate, two A levels or equivalent qualification plus at least seven years' relevant experience.

Salary scale: £7194-£8160 inclusive.

Further particulars and application form from the Staffing Officer, Thames Polytechnic, Wellington Street, London SE18 6PF, to be returned by 25 March, 1986.

Thames Polytechnic is an equal opportunities employer.

NATURE CONSERVANCY COUNCIL
(Commissioned Research—
Contract Post)

**Invertebrate Red Data Books—
Higher Scientific Officer**

Applications are invited for a contract post with the Nature Conservancy Council for a fixed period of four years. The person appointed will be responsible for preparing a Red Data Book for British invertebrates other than insects, and for maintaining a data bank on those species included in the forthcoming British Red Data Book for Insects.

Qualifications: Candidates should have a first or second class honours degree, or equivalent, in Zoology or Biology with a minimum of two years relevant postgraduate experience. A broad knowledge of the British invertebrate fauna will be required combined with a proven ability for data handling, including the use of computers. Those with a degree, or equivalent, of a different nature must be able to demonstrate adequate knowledge of invertebrates.

The post will be based in Peterborough. Possession of a current driving licence would be an advantage.

Salary: Depending upon qualifications and experience, starting salary will be within the range £7788 to £10 541.

Application forms and futher details are available from: Personnel 1, Nature Conservancy Council, Northminster House, Peterborough PE1 1UA.

The closing date for receipt of completed application forms is 4 April, 1986.

Interviews will be held on 30 May, 1986.

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University of London Computer Centre

(User Support Department)

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A vacancy exists within the Applications Section for an experienced Programmer/Analyst to be engaged in computer application areas including numerical analysis, engineering, physics and some statistics. The applicant should preferably be a graduate or a postgraduate and be fluent in FORTRAN. Experience with IBM and Cray operating systems would be an advantage. The applicant is expected to be enthusiastic, with initiative and self-motivation.

The candidate most likely to succeed is one whose skill, knowledge and ability can best be deployed to improve the services offered by the Centre.

Salary will be commensurate with age, relevant qualifications and experience within the range £7055 to £12 780 plus £1297 London Allowance.

Application forms are available from the Deputy Secretary, ULCC, 20 Guilford Street, London WC1N 1DZ. Tel 01-405 8400, Ext 341. Technical enquiries should be addressed to Dr O. C. Penge, Head, Applications Section, Ext 369.

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AUSTRALIA

CSIRO

CHIEF OF DIVISION

CSIRO INSTITUTE OF ANIMAL AND FOOD SCIENCES DIVISION OF FOOD RESEARCH SYDNEY, NSW

Applications are invited for the position of Chief, Division of Food Research, from scientists with established records of personal research achievement and leadership in food science or related disciplines. The position will become vacant when the present Chief, Dr J. H. B. Christian, completes his term of appointment on 31 December, 1986.

CSIRO's charter covers research into problems of primary and secondary industries and also such fields of community interest as human nutrition, the environment, and the development and use of natural sources.

CSIRO's research activities are grouped in five Institutes. At present the Division of Food Research is a member of the Institute of Animal and Food Sciences, which comprises the Divisions of Animal Health, Animal Production, Fisheries Research, Food Research, Human Nutrition, Molecular Biology, Tropical Animal Science; the Australian Animal Health Laboratory; and the Wheat Research Unit. Regrouping of Divisions into more sectorally-based Institutes is under consideration.

The Division of Food Research has three main laboratories: the Food Research Laboratory in Sydney, NSW; the Meat Research Laboratory in Brisbane, Queensland; and the Dairy Research Laboratory in Melbourne, Victoria. The headquarters of the Division are located in the Food Research Laboratory. The total staff of 324 includes 147 professional scientists.

The Division of Food Research conducts research programs in food science and technology directed generally towards improving the quality and safety of fresh and processed foods both for Australian consumers and for export markets. The processed food industry is the largest in output and one of the most dynamic of Australia's manufacturing industries. Processed food is a high-priority product for expanding export trade, and the Division has an important role in providing research back-up for this expansion.

The Chief of the Division will be responsible to the Director of the Institute of Animal and Food Sciences for the leadership, development, scientific direction and integration of the research programs of the Division, and will be encouraged to promote active collaboration with other Divisions, industry and research bodies working in associated areas. A recent review of the work of the Division of Food Research recommended that the Division become more interactive with industry and more entrepreneurial in its approach, and the Chief will be expected to take a lead in this respect.

The salary will be not less than $62 252 pa plus an expenses of office allowance of $1355 pa.

Appointment to CSIRO is for an indefinite period and carries Australian Government superannuation benefits, subject to normal conditions. The position of Chief of Division is offered for a negotiable term of the order of five to seven years, with subsequent options for a further term, if mutually desired, or for a senior position in the Organisation.

The Executive of CSIRO has appointed a Search Committee to seek suitable candidates for this position. Dr K. A. Ferguson, Director of the Institute of Animal and Food Sciences, would be pleased to provide further information about the Division, to discuss the position with potential applicants, and to receive advice about the appoinment from people with a particular interest in it. Dr Ferguson may be contacted at the address below, or by telephone at Canberra (062) 484637.

Persons with suitably outstanding qualifications, including research leadership experience, are invited to apply. Applications stating full personal and professional details, the names of at least three professional referees and quoting reference A2431 should be directed to:

The Director
CSIRO Institute of Animal and Food Sciences
PO Box 225
DICKSON ACT 2602
AUSTRALIA
by 17 April, 1986

CSIRO IS AN EQUAL OPPORTUNITY EMPLOYER

MORE VACANCIES ON PAGES 2–17

Chemists for Structure Elucidation

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We are also looking for a young **NMR spectroscopist** or a practising synthetic chemist with experience in interpreting NMR spectra who would like to specialise in NMR. Your initial duties will be as a practical spectroscopist within the established NMR team. In the longer term you will be expected to assume responsibility for all the NMR spectroscopy performed within a discrete business area. You should hold a good degree in chemistry and preference will be given to candidates with experience in NMR spectroscopy.

1986 Graduates—If you are keen on computers and instrumentation as well as Organic Chemistry we will consider you for the above vacancies as trainees in our spectroscopy group.

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Please apply with full details of your age, qualifications and experience to date to:
Personnel Department, ICI Plant Protection Division,
Jealott's Hill Research Station,
Bracknell, Berkshire RG12 6EY.

The closing date for these vacancies is 18 April, 1986.
Please quote reference GW/GRAD.

ICI Plant Protection Division

European Laboratory for Particle Physics
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European Organisation for Nuclear Research
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CERN, the European Organisation for Nuclear Research, located near Geneva, Switzerland, has a vacancy for a

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Candidates should have a PhD in Physics or in a related field, a completed higher education in librarianship and experience in the management of a library or information centre. They should be familiar with modern library techniques. Very good knowledge of English and French is required.

The incumbent will take an active part in all questions related to scientific information, library services and scientific publications of CERN. He will maintain contact with relevant professional bodies and other libraries and information centres working in the same field.

The starting net salary, according to experience and qualifications, is approximately 7500-Swiss francs per month, plus family, non-resident and children's education allowances where applicable.

For application forms, please write to:

Head of Personnel, CERN, 1211 Geneva 23, Switzerland, quoting the reference TH-SIS.

UNIVERSITY COLLEGE OF SWANSEA

LECTURER

Applications are invited for the vacancy of Lecturer in the Department of Civil Engineering. Candidates should have an interest and experience in applications of computers to the solution of Civil Engineering problems (CAD expertise will be useful in view of the substantial facilities now being developed at Swansea). The areas of teaching and research which the candidate will undertake could be in fluid mechanics, geomechanics or structures.

The appointment, which will be from the soonest date that can be arranged, will be on the scale £8020-£15 700 pa, together with USS/USDPS benefits.

Further particulars and application forms (two copies) may be obtained from the Personnel Office, University College of Swansea, Singleton Park, Swansea SA2 8PP, to which office they should be returned by Friday, 18 April, 1986.

LECTURERS

Applications are invited for the vacancies of Lecturer in Biochemistry and Lecturer in Microbiology in the School of Biological Sciences. Applicants with research interests in any aspects of these disciplines will be considered but preference may be given to candidates with interests in nucleic acid biochemistry or physical biochemistry (Biochemistry vacancy) and the molecular biology of microorganisms or microbial biotechnology (Microbiology vacancy).

The appointments, which will date from 1 October, 1986 or as soon as possible thereafter, will be at the lower end of the scale £8020-£15 700 pa, together with USS/USDPS benefits.

Further particulars and application forms (two copies) may be obtained from the Personnel Office, University College of Swansea, Singleton Park, Swansea SA2 8PP, to which office they should be returned by Friday, 2 May, 1986

SOUTH MANCHESTER HEALTH AUTHORITY

Christie Hospital and Holt Radium Institute

Regional Department of Medical Physics and Bioengineering

BASIC GRADE PHYSICIST
(Computer Scientist)

Applications are invited from honours graduates in computer science, physics or electronics engineering who have an interest, and preferably postgraduate qualification or practical experience, in computer applications.

The scientist will support the activities of the Radiation Physics, Radioisotopes, Radiation Protection and other groups of the department by providing computer expertise to maintain existing software and to develop new microcomputer based systems, using custom programming and commercial software packages.

Whitley Council conditions of service apply.

Salary £6288 with annual increments to a maximum of £9432. Starting salary for candidates with a first or second class honours degree is £7032 and for those with appropriate postgraduate experience up to £7548.

Applications forms and job description from the Assistant Administrator, Christie Hospital, Wilmslow Road, Manchester Tel 061-445 8123 Ext 520. Please quote reference 86/19. Closing date: 7 April, 1986.

Research Biochemists

Bass, the largest brewing company in UK, requires two Research Biochemists to join the progressive and expanding research team based at Headquarters in Burton-on-Trent.

Main duties will be to carry out research on diverse aspects of the brewing process from barley physiology and enzymology to the quality of the finished beer.

The successful candidate will preferably have a Ph.D in Biochemistry or Chemistry and two years' relevant experience gained within a brewing or food environment is also required. However, the prime requirements are for versatile young scientists displaying flair, enthusiasm and sound endeavour. Confidence, maturity of mind and a high degree of self-motivation are essential.

Liaison with academic laboratories and the publication of results is encouraged wherever possible.

Excellent salary and good benefits including generous life assurance, pension, company share scheme, products allowance and BUPA comprise a highly attractive package.

If you are interested, please apply in writing, enclosing detailed career history to:-

Senior Personnel Officer,
Bass Public Limited Company,
137 High Street, Burton-on-Trent DE14 1JZ.

Bass
Public Limited Company

Teachers/Teacher-Trainers of Maths, Science.

Cut out for the Third World?

If you are qualified in any of the following areas, your presence is urgently required to teach in the Third World.

Mathematics. Secondary school posts in the Caribbean, Malawi, Sierra Leone, Solomon Islands, Tanzania and Zimbabwe. ☐

Science. Secondary school posts in the Caribbean, Ghana, Kenya, Malawi, Nigeria, Sierra Leone, Tanzania and Zimbabwe. ☐

Teacher Training. There are posts in teachers' colleges in Ghana and Sierra Leone for teachers of Science and Maths. The job will include subject and methodology teaching as well as supervision of students' teaching practice. An interest in developing teaching aids using local materials would be an advantage. ☐

A professional teaching qualification at the primary or secondary level is required for some posts. Applicants for the teacher-training posts should have a number of years experience.

VSO volunteers should be without dependants and willing to work for payments based on local rates. Postings are for two years and most local education authorities should be prepared to consider granting leave of absence.

For details of these and other posts please complete and return.

I'm interested in volunteering. My qualifications or experience are:

VSO is working overseas

Name________________

Address________________

VSO also needs: builders, engineers, teachers, horticulturists, community & health workers, fishermen and many more.

NS/20/3

Post to: **Enquiries Unit, Voluntary Service Overseas, 9 Belgrave Square, London SW1X 8PW. (22p S.A.E. appreciated)** Charity no. 313757.

DULWICH COLLEGE
requires
SENIOR PHYSICS LABORATORY TECHNICIAN
JUNIOR PHYSICS LABORATORY TECHNICIAN

Duties will include, the provision, and sometimes the setting-up of apparatus for lessons in the Physics department of this independent boys' school, organisation of storage and stock-control for the apparatus in the six laboratories, help in the preparation of practical examinations. Willingness to undertake some repair and construction work may be an advantage. The senior technician should be an experienced person who is willing to help in the training of the junior. Salaries will be based on ILEA scales with Inner London weighting, the starting point will depend on applicants' experience. Applications, with the names of two referees, to The Bursar, Dulwich College, London SE21 7LD.

Cambridge Research Biochemicals Ltd, have a vacancy for a

Graduate Technician

in the Product Development Division.

CRB is a rapidly expanding Company in the biotechnology field, manufacturing materials and instrumentation for use in university, hospital and pharmaceutical research.

The position involves the large scale production of reagents for chemical synthesis. Experience in working in a pilot plant chemical facility would be an advantage, but is not essential. Candidates should hold a degree or equivalent in chemistry.

A letter of application including a full cv and the names and addresses of two referees should be sent to: Mrs Wendy A. Wade, Production Manager, Cambridge Research Biochemicals Ltd, Button End Industrial Estate, Harston, Cambridgeshire CB2 5NX.

Aerosol Development Technologist

Having pioneered the pressurised aerosol for inhalation therapy, 3M Health Care are one of the world's leading suppliers of pharmaceutical aerosols. Continued expansion and internal promotion has created this challenging opportunity for a young Chemist or Pharmacist to carry out development of aerosol formulations for inhalation and topical use for both the Company range of products and commercial customers.

A graduate in a relevant discipline, industrial experience in the pharmaceutical or aerosol fields would be advantageous, although not essential.

In return for your commitment, we offer an attractive salary and excellent prospects for career growth with this major international company.

Please apply with full CV to the Personnel Department, 3M Health Care, Morley Street, Loughborough, Leicestershire LE13 1BB.

3M Health Care **3M**

THE UNIVERSITY COLLEGE OF WALES, ABERYSTWYTH

WELSH PLANT BREEDING STATION

(Grant-aided by the Agricultural and Food Research Council)

HIGHER SCIENTIFIC OFFICER

(Three year Appoinment)

Applications are invited for an HSO, in the Crop Improvement Division, to work on a project planned jointly between the Agricultural and Food Research Council and Institut National de la Recherche Agronomique (INRA), to study the effect of drought and of timed irrigation on floral morphogenesis, ovule fertilisation and stability, and seed development in white clover. This project is part of the programme at the Welsh Plant Breeding Station to examine possible ways of improving seed production of white clover. The work will be conducted largely at the WPBS but occasional travel to Montpellier will be necessary for discussions and collaborative experiments with INRA.

Applicants should have a first or upper-second class honours degree in a relevant science subject with at least two years' postgraduate experience. Experience in crop and/or plant physiology is essential and a knowledge of plant water relations is desirable. Knowledge of French advantageous.

The successful applicant will be expected to take up the appointment on 1 April, 1986, or as soon as possible thereafter. The contract will end on 31 March, 1989.

Pay Scales (HSO): £7788-£10 541.

Non contributory pension scheme, but all male employees contribute 1½% to widows' pension benefits.

Annual Leave: 22 days plus 10½ Public and Privilege holidays per annum.

Written requests for further particulars and application forms should be made to The Secretary, Welsh Plant Breeding Station, Plas Gogerddan, Aberystwyth, Dyfed, to whom completed application forms should be returned. Closing date for applications is 18 April, 1986. (Quote reference 86/1).

The WPBS is an equal opportunities employer.

MORE VACANCIES ON PAGES 2–17

Econometrician/ Applied Statistician

Citibank Consumer Services Group – part of the worldwide Citicorp organisation is actively developing a full range of financial services to attract and retain customers in the many Citicorp owned businesses throughout Europe.

The Divisional Headquarters is seeking to recruit another member to a small team of analysts whose role is to provide support services to these businesses by researching and developing models of consumer behaviour.

The successful applicant will probably have or be working for a post-graduate qualification or good first degree in Econometrics or Statistics. You will communicate well in written and oral presentation and bring a creative and analytic mind to a wide range of projects. The job will involve some travel. A knowledge of SPSS of Fortran in an IBM environment would be useful.

As well as offering an exciting career in a demanding field, the vacancy carries an attractive salary, and a full range of benefits, including low cost loan and mortgage facilities after a qualifying period, season ticket loan, non-contributory pension scheme and health insurance.

If you think your results or talent will match our needs write now with full personal details to: Hilary Wright,
Citibank,
364-366 Kensington High St.,
London W14 8YQ.
Telephone: 01-438 1979.

CITIBANK

BIOCHEMIST IN HERBICIDE RESEARCH

Plant Protection Division is one of ICI's fastest growing Divisions. The centre for our world wide research is at Jealott's Hill where we invent and develop new pesticides for our international agrochemical business. Currently we are seeking to recruit the fourth member of a team which is engaged in Herbicide Biochemistry research. The job will be a mixture of specific project work, for which skills in enzyme purification assay development are needed and the provision of broad ranging technical laboratory support to the team.

The successful candidate will have a bachelors degree or equivalent in a biochemical discipline with at least one years' laboratory experience. To make a key contribution you will need to have good laboratory skills and a personality that allows you to exercise your initiative whilst at the same time responding to the needs' of the research team. The position is a challenging one which offers the opportunity for considerable personal development in a stimulating research environment.

Jealott's Hill Research Station is located in pleasant surroundings between Bracknell and Maidenhead. We offer good salaries and other benefits including membership of the Profit Sharing Scheme and Pension Fund. There is a staff restaurant, recreation club and shop on site.

Candidates should apply to the address below, giving a cv covering details of their career to date with any relevant experience.

Personnel Department, ICI Plant Protection Division,
Jealott's Hill Research Station, Bracknell, Berkshire
RG12 6EY.

Please quote reference BC/DKL.

The closing date for this vacancy is 27 March, 1986.

ICI Plant Protection Division

HARINGEY HEALTH AUTHORITY

North Middlesex Hospital

JUNIOR 'B' MEDICAL LABORATORY SCIENTIFIC OFFICER

We have a vacancy in the Haematology Department of this busy District General Hospital for a Junior 'B' MLSO.

The successful applicant for this training post will rotate between the three sections of the Department. This modern well equipped laboratory offers interesting and varied work as well as excellent facilities for study, including day release and in-service training.

A major computer system has recently been installed for the department's records and reports.

Minimum qualifications are two science GCE 'A' levels, one of which must be Chemistry or an appropriate science degree.

Starting salary at age 18 £4785 pa rising to £5949 pa inclusive of London Weighting.

Job descriptions and application forms from the Personnel Department, North Middlesex Hospital, Sterling Way, Edmonton, N18 1QX. Tel 01 807 3071 Ext 571.

Closing date two weeks after insertion.

UNIVERSITY OF NEWCASTLE UPON TYNE

Department of Civil Engineering

Transport Operations Research Group

On-line arrival time estimation for public transport systems

RESEARCH ASSOCIATE

Applications are invited for the post of Research Associate to carry out research in the above field. The project is concerned with the estimation of the times of arrival of buses at a particular location from data collected in real time at various points in the bus network. The post is funded by the SERC for a fixed period of 18 months.

Applicants should have a higher degree or appropriate postgraduate experience. Starting salary will be up to £9000 pa on the Range 1A scale, £8020-£12 780, according to age, qualifications and experience.

For further particulars about this post contact Dr M. G. H. Bell, Transport Operations Research Group, Claremont Tower, The University, Newcastle upon Tyne NE1 7RU, to whom applications should be sent by 4 April, citing three referees and enclosing a cv.

THE WILDFOWL TRUST— SENIOR RESEARCH OFFICER

The Wildfowl Trust requires a Senior Research Officer to join its small research team based at the Trust's headquarters in Slimbridge, Gloucestershire. The appointment will initially be for a period of four years; starting salary within the Civil Service Higher Scientific Officer scale: £7788-£10 541.

The officer will primarily be concerned with the organisation of the Trust's ringing programme and with the analysis of ringing recoveries together with other data. Candidates should have a degree in a biological science and at least three years' experience in research, including the writing of scientific papers and reports. Substantial knowledge and experience of computing, preferably working with micro-computers and using BASIC, is essential. Experience of bird ringing would be an advantage; candidates should hold a clean driving licence.

For further details write to: The Director of Research and Conservation, The Wildfowl Trust, Slimbridge Glos GL2 7BT.

Assistant Patents Officer

Career move for a young Graduate Chemist

North London ***c £10,000***

If you are expecting to graduate with a good honours degree in chemistry with a strong emphasis on organic chemistry – preferably allied to a lively interest in the biological sciences – then we can offer you an opportunity to start a career in the exciting field of patent work.

As an Assistant Patents Officer based at our offices in Islington, North London, you will be responsible for the general administration of patent matters and the filing and prosecution of patent applications relating to inventions originating within our research establishments.

We offer an attractive salary, with initial earnings in the region of £10,000 including bonus and London Allowance. Benefits are of the level expected from a leading, £multi-million international pharmaceutical company and include non-contributory pension scheme, and season ticket loan.

Please write or telephone for an application form to: Miss Jan Turner, Personnel Department, Glaxo Holdings p.l.c., Clarges House, 6-12 Clarges Street, London W1Y 8DH. Tel: 01-493 4060 ext. 300.

***Glaxo** Holdings p.l.c.*

Overseas Registration Manager

Home Counties £15,000-£18,000

Our clients are one of the leading research based international pharmaceutical companies. They now seek an enthusiastic professional to head up their Overseas Registration Department.

Based in the UK, the successful candidate will report to the European Regulatory Director in the USA, and key aspects of the post will include:

- Management of a small, experienced team.
- Registration of the company's products in Africa, the Middle East, India, Pakistan and South Africa.
- Close liaison with the Medical, Marketing, and Production Departments in the UK, as well as the UK Registration Group.
- Some travel to the USA and other relevant overseas countries.

Applicants should hold a life science degree, ideally with a postgraduate qualification, and have several years' experience in drug registration – ideally encompassing some overseas registration work, although this is not essential. Personal attributes should include a self-motivating resourceful and common sense approach, with the ability to communicate successfully at all management levels.

The starting salary is likely to be in the range £15,000 to £18,000 p.a. Additional benefits include 23 days' annual holiday, subsidised private medical insurance and generous relocation expenses, if required.

Please write in confidence for an application form, or 'phone to discuss the post further before applying:

Talentmark
Leaders in Health Care Recruitment

Bryan J Oswald, Talentmark Limited,
King House, 5-11 Westbourne Grove,
London W2 4UA. Tel: 01-229 2266.

MORE VACANCIES ON PAGES 2–17

New Opportunity in Exploratory Research

Richardson-Vicks is a major international company recognised as one of the leaders in the manufacture and marketing of pharmaceutical and toiletry preparations. Our growth and product development programme has been backed by continuous and high profile Research and Development activity.

An opportunity has been created within our Skin and Hair Research section which will involve the following:

* Examining and measuring the effects of products on skin and hair.
* Developing research techniques to measure the physical properties of skin and hair.
* Product evaluation and claim support.

Candidates should have a good degree in Biological or Physical Sciences. Some working knowledge related to the skin/hair area would be desirable but is not essential.

The salary and terms and conditions associated with this position are attractive and in line with those associated with a major employer.

Career development prospects are excellent.

Telephone for further information or write with full CV to Simon Brocket, Personnel Services Manager, Richardson-Vicks Ltd., Rusham Park, Whitehall Lane, Egham, Surrey TW20 9NW. Tel: Egham (0784) 34422.

Richardson-Vicks

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE

Department of Clinical Tropical Medicine

MEDICAL LABORATORY SCIENTIFIC OFFICER

A well-qualified technician (BSc, HTec or equivalent) is required to assist with a project on the detection of toxicants (principally bacterial enterotoxins) in vitro. Experience in cell culture, microtiter equipment, bacteriology, staining techniques and computing are all relevant.

The post is for one year in the first instance. Salary scale £7092-£8126 inclusive. Please write with full cv to Helen Abbott, Personnel Office, London School of Hygiene and Tropical Medicine, Keppel Street, London WC1E 7HT or Tel 01-636 8636, Ext 203 for an application form and further details, quoting reference CTM1. Closing date 4 April, 1986.

SENIOR TECHNICIAN—LAB MANAGER

Required for new "Molecular Virology and Cancer" branch of the Ludwig Institute at St Mary's Hospital, London. Primary responsibility to control ordering and laboratory inventory. Minority of time spent doing laboratory bench work. Would suit experienced Research Officer interested in assuming further responsibility. Preferred candidate would have degree or equivalent and several years experience in molecular biology/cell culture laboratory. Must have an enthusiastic and flexible attitude to work. Vacant from June 1986. Pay scales similar to MRC. Applications should include cv and names of two referees and be sent to Dr P. J. Farrell, Ludwig Institute for Cancer Research, St Mary's Hospital Medical School, Norfolk Place, Paddington, London W2 1PG.

Senior Pathologist

Smith Kline & French is a major pharmaceutical company with a large and expanding commitment in a number of research areas.

We are looking for a Senior Pathologist with experience in Toxicological Pathology and with a strong background in Clinical Pathology. This is an opportunity for a man or woman with ambition, initiative, flair and drive to make a significant contribution to our programmes. There is considerable scope, the position will be styled to match the individual's abilities and expertise; research in applied areas will be encouraged.

A veterinary or medical graduate and/or an appropriate research background is desirable. Candidates should be eligible for MRC Path.

There is an attractive salary and excellent benefits including a company car.

Please send a detailed cv quoting reference number NS/26/TEF to Dr. T. E. Forster, Personnel Manager, Smith Kline & French Research Limited, The Frythe, Welwyn, Herts AL6 9AR.

SK&F

NATIONAL INSTITUTE FOR MEDICAL RESEARCH

RESEARCH OFFICER

Laboratory of Molecular Embryology

Applications are invited for the post of Research Officer to provide technical assistance on a project to study the molecular mechanisms of gene regulation and homeobox function in early mouse development. The project involves the characterisation of cloned DNA sequences, gene transfer and the construction of transgenic mice. Experience in genetics recombinant DNA techniques and/or embryology would be an advantage. Applicants should have a good degree (or equivalent qualification) in biological science or chemistry and preferably have several years laboratory experience in this field of work.

The salary is from £6656-£9539 per annum inclusive of London Weighting, dependent on qualifications and experience.

To apply for an application please Tel 01-959-3666 Ext 218 or write to Miss M. C. Prior, Assistant Personnel Officer, NIMR, The Ridgeway, Mill Hill, London NW7 1AA. Please quote reference RO/ME.

An equal opportunities employer.

RIVERSIDE HEALTH AUTHORITY

Charing Cross Hospital

BASIC GRADE PHYSICIST (POST PROBATIONARY)

For the Nuclear Medicine Department to join two physicists as part of scientific support for work with Radionuclides in the hospital and medical school. Experience in nuclear medicine and associated computer techniques is essential and experience in radiation protection of unsealed sources would be an advantage. Involvement in other scientific development work undertaken within the department will be actively encouraged.

Applicants must have a first or second class honours degree in physics.

Salary: £8417-£10 565 pa inclusive.

For informal discussions contact Miss B. E. Jones on 01-748 2040, Ext 2412/2411.

Further details available from the Unit Personnel Department, Parsons House, Charing Cross Hospital, Fulham Palace Road, Hammersmith, London W6. Tel 01-748 2040, Ext 2992.

Closing date 4 April, 1986.

UNIVERSITY OF GLASGOW
BIOTECHNOLOGY UNIT

RESEARCH ASSISTANT

Novel Methods for Protein Engineering

Applications are invited for a two year position to test a novel method of protein engineering using pyruvate kinase from yeast as a model. The project which is funded by The Wellcome Trust, will involve a range of techniques including site-directed muta-genesis, analysis of pyruvate kinase mRNAs, and some enzyme kinetics. Candidates with a PhD or several years of postgraduate experience are encouraged to apply for the position which will start on 1 October, 1988. The successful applicant will have the opportunity to broaden his/her expertise within an active centre for biotechnology and molecular genetics.

Starting salary on RAS Salary Scale (Range 1A). Applications, giving full cv and two referees should be submitted before 31 May, 1986, to Dr Alistair Brown, Institute of Genetics, University of Glasgow, Church Street, Glasgow G11 5JS (Tel 041 339-8855, Ext 5110), from whom further details may be obtained.

ASSOCIATION FOR THE ADVANCEMENT OF BRITISH BIOTECHNOLOGY

APPOINTMENT OF EXECUTIVE OFFICER

This important, new, and growing Association, having completed its first year's operations has decided to appoint a full time Executive Officer. This presents an unusual opportunity for a person of drive and capability to assist in the growth and development of an Association serving a newly developing high technology industry.

The position would be attractive to someone with a biotechnological back-ground who may well be in early or mid career in industry, commerce, or academe, and looking for a challenging new appointment. The Council of the Association is primarily looking for a person with executive and public relations skills, drive, and "presence".

The Council is fully aware of the terms and conditions necessary to attract a suitable person to the position. The precise location has yet to be determined and may be influenced by the person appointed.

Interested persons should write briefly, with cv to the Secretary of the Association: Dr D. H. Sharp OBE, Greenhill House, Shoreham Road, Otford, Sevenoaks, Kent TN14 5RN.

UNIVERSITY OF WALES COLLEGE OF MEDICINE

Department of Geriatric Medicine

Applications are invited for the post of

RESEARCH OFFICER

in the Department of Geriatric Medicine. The person appointed will join a group investigating vitamin D metabolism and responses to stress in the elderly by measurement of subpopulations of T-lymphocytes.

Applicants should have a degree in Biochemistry or a closely related discipline. The appointment will be for three years on the scale for University Research and Analogous Staff Grade IB within the range £7055-£9495, starting point dependent upon qualifications and experience.

Further particulars may be obtained from the Registrar and Secretary, University of Wales College of Medicine, Heath Park, Cardiff CF4 4XN (Tel 0222/755944, Ext 2296) to whom applications in the form of a cv with the names and addresses of two referees should be submitted by 4 April, 1986 (quoting Ref No G12/3).

KING'S COLLEGE LONDON (KQC)

Department of Geography

LABORATORY TECHNICIAN GRADE 5

A technician is required to be responsible for the running of a modern chemical laboratory which is used for teaching and research in soils, hydrology and sedimentology. Applicants should be suitably qualified to HNC/H. Tec or equivalent with eight-nine years experience in laboratory work and competent in the techniques expected of a Grade 5 technician as specified in the Manual of Implementation. A knowledge of electronics and computing would be an advantage.

Salary for the post will be within the range £6927-£8088 pa plus £1395 pa London Allowance.

Please apply in writing, giving full details to Mr G. A. Cuthbert, Assistant Personnel Officer, King's College London (KQC) Strand Campus, Strand, London WC2R 2LS. (Quoting reference 237028).

**NEW SOUTH WALES
INSTITUTE OF TECHNOLOGY
SYDNEY, AUSTRALIA**

***Equal Employment Opportunity
is Institute Policy***

SCHOOL OF BIOLOGICAL AND BIOMEDICAL SCIENCES

HEAD

DEPARTMENT OF CELLULAR PATHOLOGY

$A44,541 p.a.

The School of Biological and Biomedical Sciences is adjacent to the Royal North Shore Hospital, Sydney. There are well equipped laboratories for teaching and research in Pathology, Microbiology, Biochemistry and Applied Biology. The School offers undergraduate degree programmes in Biomedical Science, Biotechnology, Environmental Biology and Urban Horticulture. The School also offers Masters degrees by coursework in Clinical Measurement and Environmental Toxicology, Masters degrees by thesis and a doctoral programme jointly with Macquarie University.

Applications are invited for the position of Principal Lecturer and Head, Department of Cellular Pathology. The appointee will be responsible to the Head of School for the teaching and development of undergraduate and postgraduate courses in cellular pathology. This will include the continuing development of programmes in basic pathobiology, histotechnology, immunology, haematology, diagnostic cytology and cytogenetics. The appointee will also be expected to encourage research in cellular pathology, and to make recommendations on new postgraduate programmes.

It is anticipated that the appointee will be qualified in medicine or an area of medical science, possess appropriate postgraduate qualifications and have substantial professional experience in pathology.

Preliminary enquiries may be made in confidence to Dr. C. D. Field, Dean, Faculty of Life Sciences, on Ph: (02) 439 2095.

Closing date: 6th May, 1986, Reference No. 86/066.

CONDITIONS

Fares and contribution toward removal expenses are provided for overseas appointees. A Housing Loan Scheme is available plus opportunity exists to contribute to Superannuation. Approval may be given for undertaking limited consulting work.

An information sheet outlining duties and conditions relating to the positions is available from the address below.

Applications should include a detailed curriculum vitae and the names and addresses of three referees. In reply please quote reference No. and forward to:

**The Director,
NSW GOVERNMENT OFFICE,
66 STRAND, LONDON WC2N 5LZ.**

6198

NATURE CONSERVANCY COUNCIL

HIGHER SCIENTIFIC OFFICER

Hill Vegetation Management

Applications are invited for the post of plant ecologist to extend the guidelines to permissible burning and grazing management on upland sites. The person appointed will review research on the management of hill vegetation, liaise with other organisations and individuals conducting research and will develop a research programme. He or she will give advice to NCC staff and promulgate the guidelines.

The post will be under the supervision of the upland ecologist in the Chief Scientist Directorate and will be based at the NCC's Scottish Headquarters in Edinburgh. The post will last for three years in the first instance with a possibility of extension up to a maximum of five years.

The successful candidate should possess a good honours degree or equivalent in a biological subject and at least two years research experience. Familiarity with upland vegetation and agriculture is necessary. The ability to organise large data sets and write clearly for publication is essential. A current driving licence is required.

Salary: Depending upon qualifications and experience, starting salary will be within the range £7788 to £10 541.

Application forms and further details are available from Personnel 1, Nature Conservancy Council, Northminster House, Peterborough PE1 1UA.

The Nature Conservancy Council is an Equal Opportunities Employer.

THE LONDON HOSPITAL MEDICAL COLLEGE

(University of London)

MEDICAL LABORATORY SCIENTIFIC OFFICER

Applications are invited from suitably qualified graduates for the post of MLSO in the Bone and Joint Research Unit, The London Hospital Medical College. The successful candidate will be engaged in research into joint diseases using histological, mainly immunohistochemical, techniques. Further training will be available as appropriate; salary in the range £6008-£8477 plus £1084 London Weighting.

Informal equiries to Mr C. J. Pirie, Chief MLSO, Tel 01-247 5454, Ext 423. Application forms should be obtained and returned to The Secretary, The London Hospital Medical College, Turner Street, London E1 2AD within 18 days of the appearance of this advertisement.

THE UNIVERSITY OF LIVERPOOL

Department of Physiology

TECHNICIAN GRADE 3

Required to work on a project concerning the control of post-translational modifications to alpha-tubulin during axonal growth in the mammalian brain.

Candidates must possess ONC or appropriate equivalent as a minimum qualification plus three years' experience in biochemistry, physiology or related disciplines. Applications from appropriately qualified graduates welcome.

This post is available for one year in the first instance.

Salary £5683 pa.

Application forms may be obtained from The Registrar (NAS), The University, PO Box 147, Liverpool L69 3BX. Ref: PER/941.

MORE VACANCIES ON PAGES 2–17

NMR APPLICATIONS CHEMIST

Are you a specialist in NMR with an established reputation in your field? If so, you could be the ideal person to run the new Varian Applications Laboratory, opening shortly in the UK.

As one of Varian's experts in NMR spectroscopy the Applications Chemist will provide scientific and technical support to our customers and to the sales team. You will be responsible for undertaking applied research projects, assisting in application and product development and will represent Varian at scientific meetings.

To be successful in this position it is envisaged you will hold a PhD in chemistry and have extensive experience of NMR in an academic or industrial environment. A flair for lecturing would be advantageous.

We will offer the right candidate a competitive remuneration package, including generous fringe benefits.

If you are interested in this exciting opportunity please apply in writing, giving details of current remuneration, to: **Mrs A. J. Poague, Varian Associates Ltd, 28 Manor Road, Walton-on-Thames, Surrey KT12 2QF.**

varian

Varian Associates Limited,
28 Manor Rd., Walton-on-Thames, Surrey KT12 2QF.

THE CENTRAL BLOOD LABORATORIES AUTHORITY
has a vacancy at its
PLASMA FRACTIONATION LABORATORY
(OXFORD)
for a

TECHNICIAN

This small group is concerned with the production and development of various agents extracted from blood plasma. The Laboratory's products are used in the Health Service for the treatment of blood clotting disorders.

The work involves the production of an established range of protein concentrates and also the development and production of new concentrates for clinical trial. There will be opportunities to assist in the development of new products and new methodology.

The successful candidate will possess a BSc, or equivalent, in Biochemistry or in a biological science and will preferably have had a year's relevant working experience.

Starting salary, depending on qualifications and experience, will be in the range of £6008-£8477 pa.

For an application form please telephone Oxford (0865) 62002 quoting ref PFL/RD/T3/RP or write to the Secretary, Plasma Fractionation Laboratory, Churchill Hospital, Oxford OX3 7LJ.

UNIVERSITY OF LEICESTER
Department of Surgery
POSTDOCTORAL RESEARCH ASSISTANT

Applications are invited for this research position funded by the National Kidney Research Fund for two years. The work will involve the study of specificities of human alloantibodies in the field of renal transplantation. Experience of tissue culture and/or immunochemical techniques would be of advantage. Salary in the range £8020-£9880 pa.

Applications, to include cv and names of two referees to: Dr T. Horsburgh, Department of Surgery, Leicester General Hospital, Leicester LE5 4PW.

ICI

ORGANICS DIVISION HUDDERSFIELD WORKS

ORGANIC CHEMIST HETEROGENEOUS CATALYSIS

SALARY £15 000+

The Huddersfield Site is part of the Company's Fine Chemicals Manufacturing Organisation. It manufactures a wide range of chemicals for use in the Agro-chemical, Pharmaceutical, Polymer, Plastic and Colour industries.

A vacancy exists within the Process Technology Department on the site for an Organic Chemist to work in the field of heterogeneously catalysed chemical reactions. The succesful applicant will lead a small team which is already involved in work of significant importance to the Company.

The work is concerned with the laboratory development of catalysed processes and progression of development through pilot plant scale trials to full scale manufacture.

Applicants should possess an Honours Degree in Chemistry with, preferably, a postgraduate qualification. Experience in heterogeneous catalysis is essential with a knowledge of the techniques involved in catalyst characterisation and in the elucidation of the mechanism of catalysed chemical reactions. Applicants should be cable of developing a range of contacts within and outside the Company in order to exploit the latest advances in catalyst technology.

Applicants must also be capable of leading a small team of scientists, developing work plans and monitoring/controlling activities leading to implementation of the plans.

There is scope for career advancement for a suitable applicant.

The successful applicant will be offered an excellent salary/conditions of service and a relocation package is available where necessary.

Please send full cv to:

Mr R. D. Thompson, Personnel Officer
ICI PLC
Organics Division
Leeds Road
Huddersfield
West Yorkshire HD2 1FF

ICI is an Equal Opportunities Employer

ICI

WYE COLLEGE
University of London

Applications are invited from graduates for a

TWO YEAR RESEARCH ASSISTANTSHIP

in Animal Breeding and Production in the Department of Agriculture. There are two main project areas:—

(a) The selection of pigs for various production characteristics.

(b) The improvement of litter size and ovulation rate in sheep.

The appointment will be on salary 1B for Research and Analogous staff (currently £6964 to £10 900).

Letters of application including cv and two referees should be addressed to the Personnel Officer, Wye College, Wye, Nr. Ashford, Kent. Tel 812401 Ext 228 from whom further particulars are available.

Closing date for applications is 31 March, 1986.

Wye College is an Equal Opportunities Employer.

INSTITUTE OF DERMATOLOGY
(University of London)
GRADUATE RESEARCH ASSISTANT

Required to work on a project designed to study the role of lymphocyte chemoattractants in inflammatory skin disorders, under the supervision of Dr Richard Camp. Applicants should have, or be about to complete, a degree in one of the biological sciences. Knowledge of chromatographic purification or biological assay methods would be an advantage.

Funding, from The Wellcome Trust is for up to three years: starting salary £6865 plus £1297 London Weighting; Scale 1B.

Two copies of cv, plus the names of two referees, should be sent to Dr R. Camp, Institute of Dermatology, Homerton Grove, London E9 6BX Tel 01-985-7061 Ext 34 by 8 April, 1986.

THE UNIVERSITY OF HULL
Department of Biochemistry
GRADE 4 RESEARCH TECHNICIAN

A Grade 4 Research Technician is required to assist in an investigation into the production of novel polymers by micro-organisms.

The post is funded by the ICI Joint Research Scheme and is tenable for three years. Minimum qualifications:- HNC in Applied Biology (or equivalent) together with 7-9 years experience in biochemical techniques. Additional experience in microbiology would be advantageous.

Salary on the scale £6427-£7393 pa.

Applications, in writing, giving details of age, qualifications, experience and the names and addresses of two referees should be sent to the Personnel Officer, The University of Hull, Hull HU6 7RX by 18 April, 1986.

SOUTH GLAMORGAN HEALTH AUTHORITY
UNIVERSITY HOSPITAL OF WALES
Rheumatology Department

MEDICAL LABORATORY SCIENTIFIC OFFICER/ JUNIOR B MLSO

£5114–£8477 depending on qualifications and experience

This post is concerned with the humoral aspects of immunology as applied to various investigative procedures in Rheumatology.

Applicants should preferably be state registered MLSO's with experience in Microbiology or Medical Biochemistry although applications are welcome from graduates with at least a second-class degree in a relevant biological science.

Application form and Job description available from: Personnel Department, University Hospital of Wales, Heath Park, Cardiff CF4 4XW.

Closing date. 4 April, 1986.

PROJECT MANAGER — ENERGY EFFICIENCY

The Energy Efficiency Office aims to help energy users improve their efficiency of energy utilisation. With the continued expansion of this influential office, a new position has been created in the Industry and Commerce Directorate.

Your overall objective will be to develop industry — specific systems of energy management, to monitor and target energy usage. This will involve working with external consultants, in conjunction with trade associations. You will be called upon to provide briefing material for senior officers and Ministers and speak at seminars. The work will involve travel within the UK.

An engineering graduate with many years' relevant experience is required. You will need a good grasp of management accounting and should be able to combine the technical knowledge of energy, combustion and heat transfer with the ability to sell the energy efficiency concept to industry and commerce management. You should be a quick learner who can assimilate enthusiastically the complex issues in energy audits and the use of energy in industrial processes and use your initiative in all undertakings.

Salary starts at £12,445 rising to £15,025 (including £1365 Inner London Weighting) according to qualifications and experience.

For further details and an application form (to be returned by 11 April 1986) write to Civil Service Commission, Alencon Link, Basingstoke, Hants RG21 1JB, or telephone Basingstoke (0256) 468551 (answering service operates outside office hours).

Please quote ref: T/6806.

The Civil Service is an equal opportunity employer

DEPARTMENT OF ENERGY

Athrofa Gogledd Ddwyrain Cymru
The North East Wales Institute
of higher education

CONNAH'S QUAY, DEESIDE, CLWYD

RESEARCH TECHNICIAN

Scale 3 £6234–£6756 pa
(Fixed-term contract to Sept 1987)

Applications are invited from suitably qualified and experienced persons to work on a project supported by the Muscular Dystrophy Group of Great Britain until Sept 1987 in the first instance, starting in May 1986. Monoclonal antibodies will be used to study the structure and function of creatine kinase isoenzymes and their expression in muscle cell cultures. Experience with biochemical, immunochemical or cell culture techniques would be an advantage

Application forms and further details from the Registrar, The North East Wales Institute, Connah's Quay, Deeside, Clwyd CH5 4BR. Tel: (0244) 817531 Ext 254). Closing date for receipt of applications 4 April, 1986. Information on the project from Dr G. E. Morris (Ext 245).

London Borough of Enfield

Toxicity Information Officer

£142·56 pw

A Graduate, with a degree in Chemistry, Toxicology or Biology? Could you set up and manage an information service on toxic chemicals in the home? It will involve the research, collation and presentation of information in displays, talks, information packs etc, liaison with other agencies and motivation of a team of 12. Relevant experience in research and the use of computers would be an advantage.

All applicants must be unemployed.

Write or telephone for an application form to Dorothy Ives at Joblink, 24 Buckingham Gate, London SW1E 6LB. Tel 01-588 2326.

JOBLINK

INFORMATION OFFICER C.£9500

To run the Library/Information Service at the Chemical Industries Association.

The Information Officer, supported by an assistant, provides an information service to member companies, to association staff and to outside enquirers.

Applicants should have training and/or experience in information science together with a qualificaton in chemistry or a related subject.

Starting salary will be around £9500 and is supported by a benefits package including luncheon vouchers, pension scheme and season ticket loan.

Application forms from: Valerie Flindall, CIA Ltd, Alembic House, 93 Albert Embankment, London SE1 7TU. Tel 01-735 3001.

OXFORD UNIVERSITY

Numerical Analysis Group

RESEARCH OFFICER

An applied mathematician, numerical analyst or similarly qualified person is required for a three year research project jointly funded by AERE, Harwell and the CEGB concerned with

three dimensional
fluid flow modelling.

The aim is to develop efficient algorithms for the 3D Navier-Stokes equations, probably based on Lagrange-Galerkin methods, and to validate these on a series of model problems. The successful candidate should have research experience in numerical analysis and/or fluid dynamics and should be a competent programmer. The project will make use of the very powerful computing facilities at Harwell and is part of the research programme of the Oxford/Reading Institute for Computational Fluid Dynamics.

Salary will be on the University Research Assistant Scale 1A, in the range £7820–£12 635 (under review) depending on age, qualifications and experience.

Further particulars from Prof K. W. Morton, Computing Laboratory, 8-11 Keble Road, Oxford OX1 3QD. Tel Oxford (0865) 54141, Ext 315. Applications, including full curriculum vitae and naming two referees should be sent by 21 April.

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£8000 + car + excellent benefits

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SSC

MORE VACANCIES ON PAGES 2—17

Defoamer Chemist

Tenneco Malros Limited suppliers of chemicals to the Paper, Adhesives, Paint and Rubber industries require a Chemist to work on the development of defoamers, antifoamers and auxiliary chemicals.

Applications are invited from Graduate Chemists aged 25-35 with experience in surfactant chemistry or analysis. Familiarity with the Paper or Paint industries would be an advantage.

Laboratory development of this product range would be supplemented by occasional visits to customers to provide technical back-up during trial situations, and would also involve plant process development.

This position is based at Avonmouth, and carries a scale salary commensurate with qualifications and experience, together with a non-contributory pension scheme.

Please write or telephone for an application form to:- Mrs. Y. M. Cant,
Albright & Wilson Resins and Organics Limited, Rockingham Works, Avonmouth, Bristol BS11 0YT. Telephone: 0272 823611.

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Scientists
sales may be for you

If you have a science qualification equivalent to degree level standard, and a few years' work experience, particularly in a hospital environment, you may be wondering what the future holds for you. If you want a high basic salary — £8000 plus, a car and other benefits, and the opportunity to progress in ability, sales may be for you. To see how we can help you, ring **0256 55955** (24 hrs) Sutcliffe Selection, 46/48 Essex Road, Basingstoke, RG21 1TB

Sutcliffe Selection

THE SPORTS TURF RESEARCH INSTITUTE

Agronomy

RESEARCH OFFICER

Applications are invited from graduates in Agricultural Botany, Agronomy or related disciplines for a three-year post concerned mainly with the nutrition of golf green turf although the applicant will be expected to assist with other projects as necessary. Candidates should have at least a 2nd Class Honours Degree, and experience of field experimentation and subsequent statistical analysis would be advantageous.

Salary will commence at £6700-£7300 depending on qualifications and experience.

Apply in writing to: The Secretary, The Sports Turf Research Institute, Bingley, West Yorkshire BD16 1AU, from whom further particulars may be obtained. Closing date for applications 8 April, 1986.

C.A.B. INTERNATIONAL

The leading world agricultural information service for scientists and technologists

SCIENTIFIC INFORMATION OFFICER

required at The Commonwealth Bureau of Soils

The Commonwealth Bureau of Soils is located at Rothamsted Experimental Station, Harpenden, Herts. The successful candidate would be located at Harpenden initially and later at C.A.B. International, Wallingford, Oxon.

DUTIES:	(I) Index term control, (II) selection of source material, (III) abstracting, and (IV) editing in connection with the preparation of records for inclusion in *Soils and Fertilisers* and *Irrigation and Drainage Abstracts*.
QUALIFICATIONS:	A first or higher degree in soil science or a related discipline is essential, together with experience in advisory or research work in soil science. A working knowledge of at least one major European language would be advantageous. Applicants must be able to render the contents of scientific publications into concise, accurate and readable abstracts.
SALARY:	In the scale £6190-£8561; £7788-£10 541, according to age, qualifications and experience.

Application form and further particulars from:
Commonwealth Bureau of Soils
Rothamsted Experimental Station
Harpenden
Herts AL5 2JQ

Closing date for applications 9 April, 1986.

Asbestos Monitoring

Vacancies exist for experienced Analysts with good practical knowledge of Asbestos Regulations and Codes of Practice. An appropriate Science Degree should be held and a current driving licence is essential.

An attractive salary will be offered together with transport, reflecting the level of responsibility and the unsocial hours required by the post.

Applications with full cv's to:
Invicta Analytical Services, 18 Invicta Close, Chislehurst, Kent BR7 6SJ

LANCASHIRE COUNTY COUNCIL
An Equal Opportunities Employer
Lancashire College of Agriculture and Horticulture

SENIOR TECHNICIAN
Science Department

Salary: £6234-£6756

Applications are invited from persons who are qualified in Chemistry and/or have a good working knowledge of Analysis. Instruments include AA and UV Spectrophotometers, continuous flow Analyser. In addition to Analysis the Senior Technician will be responsible for the day-to-day running of the Laboratory.

Further details available from the Principal Agricultural Officer, Lancashire College of Agriculture and Horticulture, Myerscough Hall, Bilsborrow, Preston PR3 0RY.

Closing date: 4 April, 1986.

THE UNIVERSITY OF LIVERPOOL

Department of Physiology

TECHNICIAN GRADE 3

Required to assist with work on the isolation and physiologic role of Vasoactive Intestinal Peptide (VIP) and related hormones, from lower vertebrates. The project involves the use of radioimmunoassay, bioassay, and the methods of preparative and analytical peptide chemistry.

Candidates must possess ONC as a minimum qualification and three years experience in any of these areas. This post would also be suitable for recent graduates in Physiology, Biochemistry, Pharmacology or a related subject.

This post is tenable for three years.

Salary within a range £5683-£6657 pa.

Application forms may be obtained from The Registrar (NAS), The University, PO Box 147, Liverpool L69 3BX. Ref: PER/940.

ANIMAL AND GRASSLAND RESEARCH INSTITUTE

TEMPORARY HIGHER SCIENTIFIC OFFICER

required for three years in the Ruminant Nutrition and Metabolism Department to work on a project to improve the prediction of voluntary intake by ruminants. This will involve the development of computer models of intake regulation in dairy and beef cattle.

Qualifications: Degree or equivalent in a biological/agricultural science with an emphasis on nutrition with a PhD or at least two years relevant post-qualifying experience. Knowledge of the use of mathematics in biology is desirable.

Starting salary: Higher Scientific Officer £7788-£8618 rising to £10 541.

Applications with cv and three referees to the Personnel Officer, Animal and Grassland Research Institute, Hurley, Maidenhead, Berks SL6 5LR by 8 April, 1986.

YOUNG GRADUATE with BSc Hons degree in Biochemistry required to assist with research project in cardiovascular disease. Salary will be on the Junior MLSO B grade (£5144-£5272 plus £1084 London Weighting). The appointment will be for a year in the first instance. For further information, contact Dr John Betteridge, Department of Medicine, University College London, Rayne Institute, University Street, WC1E 6JJ.

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Are you looking for a new scientific challenge in an international multidisciplinary environment in the food industry?

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MICROBIOLOGIST/ VETERINARIAN FOR MEAT PRODUCTS

You would be involved in:

- overall microbiological aspects of meat or meat based products through all the stages from the farm to the point of sales
- technical assistance by means of occasional visits abroad to laboratories and factories
- building up contacts with universities and translating findings of fundamental research into practical terms
- assistance in quality monitoring procedures (HACCP).

You are in possession of a MSc/PhD degree either in veterinary combined with microbiological experience or in microbiology with some experience in the veterinary field.

Knowledge of German and of computer applications would be an asset.

Please send your curriculum vitae together with details on your publications/career development and photograph to: M. von Anacker, Central Personnel Services, NESTLE, 1800 Vevey, Switzerland.

AUSTRALIA CSIRO

RESEARCH FELLOW

$27 475—$40 410

DIVISION OF ENERGY TECHNOLOGY HIGHETT, VIC

FIELD: Engineering Mathematics.

GENERAL: The Division of Energy Technology undertakes engineering research directed towards the balanced use of Australia's energy resources. The Division has a total staff of 77, including 36 professional engineers and scientists, with 70 of the staff located at the Divisional Headquarters in Highett, Victoria.

Energy Use is a major program of the Division, and within this program, research is being conducted to develop an understanding of the processes for augmenting heat transfer by stimulation of fluid flows, with the objective of improving the performance of industrial cooling systems. The Division has an established reputation in fluid mechanics and the investigation of transient phenomena.

DUTIES: The appointee will initially undertake research into the mathematics of theories describing the structure of turbulent separated flows and the relationship of these theories to promotion of convective heat transfer and generation of aerodynamic noise.

QUALIFICATIONS: A PhD degree or equivalent qualifications in mathematics or engineering mathematics plus proven research ability. An interest in the fields of aero-acoustics and heat transfer is important, together with a strong background in applied mathematics and theroretical fluid mechanics. Familiarity with advanced numerical methods for solving the transport equations that describe high Reynolds number flows is essential.

TENURE: A term of four years with Australian Government superannuation benefits available.

APPLICATIONS: Stating relevant personal particulars, including details of qualifications and experience, the names of at least two professional referees and quoting reference No A3656, should be directed to:

The Chief
CSIRO Division of Energy Technology
PO Box 26
HIGHETT, VIC 3190
by 17 April, 1986

CSIRO IS AN EQUAL OPPORTUNITIES EMPLOYER

UNIVERSITY OF OXFORD

Department of Paediatrics

SENIOR MEDICAL LABORATORY SCIENTIFIC OFFICER

Salary scale £7874-£10 403 pa (Whitley Council)

Applications are invited from candidates with a wide background in biochemical methods to join a department engaged in clinical and basic research into disease of childhood. Applicants should have experience in supervising junior members of staff and be Fellows of the IMLS. Previous experience in a research laboratory would be an advantage.

Applications, stating age, qualifications, present post, previous experience and the names of two referees should be sent to Professor E. R. Moxon, Department of Paediatrics, John Radcliffe Hospital, Headington, Oxford OX2 9DU.

COYPU RESEARCH LABORATORY, NORWICH

(Temporary appointment)

SCIENTIFIC OFFICER

To help analyse data on reproductive and population biology of coypus. Applicants should have a keen interest in functional biology and some experience of computing (eg SIR/SPSS) and statistics. Salary: £6190 pa. Period of employment: up to four months. Apply by letter, plus cv, to Dr L. M. Gosling, Coypu Research Laboratory (SO Applic), MAFF, Jupiter Road, Norwich NR6 6SP. Tel 0603 405990.

Data Magnetics Ltd., a new company based near Chester, which specialises in the development, manufacturing and marketing of high density, magnetic storage disks for the computer industry, is collaborating in a Teaching Company Scheme with Manchester Polytechnic and the University of Salford.

There are two vacancies for:

Teaching Company Associates

1. Associate based jointly at Salford and Data Magnetics Ltd. Development of automated instrumentation for on-line non-destructive characterisation of the magnetic properties of disks. The post will suit a recent graduate in applied physics, materials science or electronic engineering.

Application forms from Dr P J Grundy before 18th April 1986, Dept of Pure and Applied Physics, University of Salford, Salford M5 4WT.

2. Associate based jointly at Manchester and Data Magnetics Ltd. Development of computer based environmental testing and recording performance measurements. The post will suit a recent graduate in electronic or electrical engineering.

Application forms from Dr BK Middleton before 18th April 1986, Dept of Electrical and Electronics Engineering, Manchester Polytechnic, Chester Street, Manchester M1 5GD.

Research and/or industrial experience would be an advantage for both positions. Salary depending on experience will be in the range £7,500 – £9,500 pa.

DM
DATA MAGNETICS

ROYAL POSTGRADUATE MEDICAL SCHOOL

(Hammersmith Hospital)

Department of Bacteriology

JUNIOR MEDICAL LABORATORY SCIENTIFIC OFFICER (Grade B)

Required for the Clinical Bacteriology Laboratory. Full training in laboratory techniques and day release to Higher TEC and beyond will be given.

Applicants require at least two GCE science "A" levels or a suitable university science degree.

Salary £4149 plus £1133 London Weighting at age 18.

Application forms may be obtained from the Personnel Office, Royal Postgraduate Medical School, 150 Ducane Road, London W12 0HS, quoting Ref 5/112/NS.

Closing date: 3 April, 1986.

UNIVERSITY OF NOTTINGHAM

POSTGRADUATE RESEARCH IN APPLIED BIOCHEMISTRY AND NUTRITION

Opportunities exist for postgraduate research in the areas of Applied Biochemistry (both plants and animals) and Nutrition (both man and animals) for those who hold, or expect to gain, at least a 2(I) Honours Degree. For further particulars please contact in the first instance Professor P. J. Buttery, Department of Applied Biochemistry and Food Science, University of Nottingham School of Agriculture, Sutton Bonington, Loughborough LE12 5RD.

MORE VACANCIES ON PAGES 2–17

NIHE

NATIONAL INSTITUTE FOR HIGHER EDUCATION DUBLIN

The School of Physical Sciences offers a B.Sc. in Applied Physics, with specialisms in transducers/control, fibre optics and solid state technology; and provides a major input for other degree courses.

Applications are invited from physicists and engineers for the following positions within the **Faculty of Science.**

Senior Lecturer/Lecturers in Physical Sciences

Candidates should be well qualified academically together with industrial, academic or research experience. A background in one or more of the following areas would be an advantage: Optical Fibre Technology; Sensors; Instrumentation including Microprocessor Interfacing, Nuclear Instrumentation, Laser Applications; Semiconductor Devices. However, the School welcomes applications from candidates with other specialisms. Successful candidates will be expected to take part in the research activities of the School.

Salary Scale:

Senior Lecturer:	IR£16,659 - £22,005
Lecturer:	IR£15,152 - £19,952
Assistant Lecturer	IR£11,648 - £14,516

Application forms and further details are available from the Personnel Office, National Institute for Higher Education, Glasnevin, Dublin 9. Closing date: 2nd May 1986.

GEOCHEM

THE GEOCHEM GROUP

The Geochem Group—geological consultancy in oil exploration and production

MICROPALAEONTOLOGIST

The Geochem Group in Chester has a new opening for a Senior Micropalaeontologist. Applicants should have a relevant degree and three or more years oil industry experience working with foraminifera and ostracods. Familiarity with nannoplankton and calcareous algae would be an advantage.

Salary will be negotiable according to experience. The Geochem Group offer a comprehensive non-contributory benefit package. Applications including a detailed cv should be sent by 18 April, 1986, to the Manager of Stratigraphy, Geochem Group, Chester Street, Chester CH4 8RD.

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Pleasant working environment in a company of around 50 people. Salary £17 000 plus car.

Please write with CV to Rosemary McConkey, Director, Pharmaceutical Division, Transart Ltd, East Chadley Lane, Godmanchester, Huntingdon, Cambs PE18 8AU.

INFORMATION SCIENTIST

Temporary Contract for six months West London Pharmacy/Life Science graduate with information science experience to start work early April. Contact Task Force Pro Libro, 76 Park Road NW1 4SH, Tel 01-723 8530.

SERVICES

FOR ALL TECHNICAL TRANSLATIONS FROM JAPANESE contact Ingatestone Translators, 57 High Street, Ingatestone, Essex CM4 0AT. Tel (0277) 353863 and 354022.

BOOKS AND PUBLICATIONS

BOOKSEARCH SERVICE

Any title/subject found. SAE and details to County Books, Lynholme, Leigh Road, Pontypool, Gwent, UK NP4 8LG.

STUDENTSHIPS

JOHN INNES INSTITUTE

PhD STUDENTSHIPS IN PLANT AND MICROBIAL MOLECULAR BIOLOGY, CELL BIOLOGY AND GENETICS

Eleven studentships are offered to start in October 1986, for projects in the four departments of the Institute.

Applied Genetics Department: Plasmid transfer in natural; populations of *Rhizobium leguminosarum* (studies of natural plasmid distribution and molecular analysis of plasmid polymorphisms); Repeated sequences in the pea genome (analysis of the involvement of tandam and dispersed repeats in the generation of genetic variation and studies of specific examples of cloned repeated sequences); Selection and molecular analysis of pea seed lipoxygenase variants (studies of the basic molecular biology, development biology and biochemistry of the enzyme using immunological screening techniques and cloned probes).

Cell Biology Department: Role of plasmodesmatal structure in cell-to-cell spread of plant viruses (construction of virus-specific probes and their use in cellular localization of viruses and molecular biological and cytochemical studies of plasmodesmatal spread—joint with Virus Research Department); Characterisation and role of the plant cytoskeleton (study of microtubules and microfibrils by immunofluorescence and ultrastructural techniques).

Genetics Department: Transposable genetic elements in *Antirrhinum* (use of a cloned transposon to study transposition mechanisms and gene expression); Differential gene expression in *Streptomyces* (molecular biology of antibiotic biosynthesis, differentiation and their joint regulation); Regulation of exopolysaccharide biosynthesis in *Rhizobium* in relation to nitrogen fixation and nodulation (gene cloning and monclonal antibody analysis of nodulation genes and their products).

Virus Research Department: Molecular pathology of an RNA plant virus (cloning and sequencing of the viral genome and functional analysis in relation to pathogenesis); Molecular entomology in relation to transmission of a DNA plant virus by leafhoppes (molecular biology of the virus and its insect vector); Changes in host gene expression in virus-infected plants (cDNA and genomic cloning and protein purification to analyse symptom specific gene expression).

Students should write to the Head of the department concerned, at the John Innes Institue, Norwich NR4 7UH, for further details of particular projects and application procedures. (Applicants already in touch with the Institute need not re-apply.)

UNIVERSITY OF KEELE

Department of Biological Sciences

Applications are invited from students who have, or expect to obtain, an upper second or first class Honours degree, for

POSTGRADUATE RESEARCH STUDENTSHIPS IN BIOCHEMISTRY

(gut enzymology, lysosomes, teratogenicity, insulin secretion, photosynthesis, drug targeting); Parasitology (physiology, cellular immunology, ultrastructure, chemotherapy, developmental biology of metacestodes); Microbiology (physiology and biochemistry of fungi); Animal Physiology (including cardiovascular physiology) and Terrestrial and Freshwater Ecology.

For this year applications will be especially welcome for studentships in: cellular immunology of helminth infections of fish; molecular basis of insulin secretion; developmental biology and chemotherapy of Echinococcus; heavy metal uptake by fungi; regulation of photosynthesis.

Application forms from Senior Tutor, University of Keele, Keele, Staffs ST5 5BG. Informal enquiries to Prof C. Arme (Tel 0782-621111).

UNIVERSITY OF MANCHESTER

Pharmacy Department

RESEARCH STUDENTSHIPS

The Department offers opportunities for well qualified graduates in Pharmacy or other relevant subjects to pursue research for higher degrees (MSc and PhD) in the following areas:

MEDICINAL CHEMISTRY—Design, Synthesis, Biotransformation and Toxicology of Medicinally Active Compounds; Drug Receptor Interactions as studied by NMR.

FORMULATION SCIENCE—Controlled Release from Drug Delivery Systems; Non-invasive Methods for Studying Drug Distribution.

MICROBIOLOGY—The Permeability of the Bacterial Cell Envelope to Antimicrobial Agents; Aeromicrobiology.

PHARMACOKINETICS—Physiological Models, Disease States, Drug Interactions; Metabolite Kinetics; Data Analysis Techniques.

Interested students should contact:
Postgraduate Admissions Officer,
Department of Pharmacy, University of Manchester, Manchester M13 9PL.

THE UNIVERSITY OF WARWICK

Department of Biological Sciences

POSTGRADUATE STUDENT IN MICROBIAL BIOCHEMISTRY

Applications are invited from impending graduates in biochemistry or microbiology for an SERC postgraduate studentship leading to a PhD. The student will work with Professors N. G. Carr and R. J. Ellis on the isolation of the CO_2-concentration system from cyanobacteria and its transfer to higher plant chloroplasts. The appointment commences on 1 October, 1986 for three years. Informal enquiries can be made by phoning 0203-523544 (Carr) or 523509 (Ellis). Further information and application forms can be obtained from the Executive Officer/Academic Administration, Biological Sciences, Warwick University, Coventry CV4 7AL, Quoting Ref: NGC/RJE.

UNIVERSITY OF LANCASTER

Department of Engineering

Integrated Circuit Research

Two research studentships, awarded under the SERC cooperative award scheme in science and engineering (CASE), are available to students who would like to join a research group working in the area of computer aided testing of integrated circuits.

Close industrial cooperation, with Ferranti and IBM, will be a feature of the research which is also supported by an SERC contract granted to the integrated circuit research group. Interesting results have already been achieved and there is a high probability that a student making a substantial contribution to this work would see his results being of direct use to industry.

Applications are invited from undergraduates expecting to obtain at least an upper second class degree or recent graduates holding a similar qualification in electronic engineering, physics or a related discpline.

Further details and application forms may be obtained from:
Miss B. L. Hickson, Department of Engineering, University of Lancaster,
Bailrigg, Lancaster LA1 4YR.

The closing date for applications is 25 April, 1986.

AGRICULTURAL AND FOOD RESEARCH COUNCIL

Animal and Grassland Research Institute, Hurley, Maidenhead, Berkshire, SL6 5LR

RESEARCH STUDENTSHIP

Applications are invited from graduates in microbiology, microbiology/biochemistry or related subjects for a three-year studentship to commence October 1986.

The aim of the project is to study the mechanisms associated with fibre digestion by rumen microorganisms in relation to voluntary feed consumption in the dairy cow. Research will involve anaerobic microbiological techniques and analysis of fibre degrading enzymes.

Applicants must have, or expect to obtain, a first or upper second class honours degree.

Further information and application forms may be obtained from the Personnel Officer at the above address to be returned by 8 April, 1986.

BRISTOL POLYTECHNIC

Department of Engineering

SERC CASE STUDENTSHIP: Flexible Control for Flywheel Energy Storage

A SERC CASE studentship is available, in collaboration with British Petroleum PLC, for the development of an integrated flywheel energy storage unit for use in electrical vehicles. The project involves the development of a regenerative flywheel drive. Applicants should have, or expect to have, a good honours degree in Electrical Engineering or related discipline. The studentship is tenable for three years and the successful applicant will be registered for a PhD. For further details please contact Dr T. S. Davies, Department of Engineering, Bristol Polytechnic, Coldharbour Lane, Frenchay, Bristol BS16 1QY, or Tel Bristol (0272) 656261, Ext 489.

UNIVERSITY OF CAMBRIDGE

Department of Zoology

RESEARCH STUDENTSHIPS

It is hoped that a number of research studentships will be available in this Department from October 1986. The Research interests of the Department include Molecular Biology, Neurobiology, Developmental Biology, Behaviour and Behavioural Ecology, Biomechanics, Ecology, Comparative Physiology and Evolutionary Studies.

Please write for details of these research opportunities and for application forms to Head of Departments Secretary, Department of Zoology, Downing Street, Cambridge CB2 3EJ.

UWIST

UNIVERSITY OF WALES

Department of Applied Chemistry

AMERSHAM RESEARCH STUDENTSHIP IN ORGANIC CHEMISTRY

Applications are invited from suitably qualified chemistry graduates for the above Research Studentship, available from 1 October, 1986.

The project is concerned with structure-property relationships in new photochromic organic compounds (ie compounds which change colour reversibly on exposure to light) and will involve organic synthesis, spectroscopy, and photochemical studies. The work will be carried out under the supervision of Professor H. G. Heller.

The studentship is offered at £600 pa above current SERC rates, ie not less than £3500 for 1986/87 academic year.

Applicants should write to Professor H. G. Heller, Department of Applied Chemistry, UWIST, PO Box 13, Cardiff CF1 3XF, giving the names of two referees.

UNIVERSITY OF ABERDEEN

Zoology Department

POSTGRADUATE STUDENTSHIPS 1986

Opportunities exist for postgraduate research leading to a PhD in the following areas:-

Physiology of Cephalopod Feeding (Dr P. R. Boyle).

Serotonin and Crab Equilibrium (Dr P. J. Fraser).

Plant Secondary Compounds and Insect Feeding (Dr A. J. Mordue).

Insect Neuropeptides (Prof W. Mordue).

Clonal Analysis of Amphibian Development (Dr. G. J. MacMillan).

Interleukin Production (Mr R. G. Pugh-Humphreys).

Microevolution of Reptiles (Dr R. S. Thorpe).

Applicants should have or expect to obtain good honours degrees in zoology or a related discipline. Further details from Head of Department of Zoology, University of Aberdeen, Aberdeen AB9 2TN. Tel 0224-40241, Ext 6427.

PHARMACEUTICAL SCIENCES INSTITUTE

Aston University

RESEARCH STUDENTSHIPS

Ten or more Research Studentships are available in October 1986. Candidates should have or expect to achieve preferably a First Class Honours Degree, or an Upper Second and be able to provide two academic references. The Institute consists of six research groups, has an annual research income of £8·5K and it published over 100 papers in 1985/6. A number of projects exist in each group, of which the following are examples:

MRC Mechanisms of Drug Toxicity Group—evaluation of the link between the toxicity and metabolism of dimethyformamide, calcium homeostasis of aminoglycoside-induced toxicity.

Pharmaceutical Microbiology Group—the identification of key surface antigens of bacteria infecting trauma patients, with a view to vaccine development.

Drug Mechanisms (Pharmacology) Group—the relationship between the vascular and behavioural effects of certain vasoactive drugs with respect to their mechanisms of action in migraine.

Drug Development Group—synthesis and skin delivery of novel antipsoriatic agents: design of sequence specific DNA methylating as potential anti-tumour drugs.

Pharmacy Practice Group—evaluation of the change in the role of the community pharmacist.

Studentships in the Cancer Chemotherapy Group were advertised in January. Details of the groups, their projects and application forms can be obtained from Dr J. A. Hickman, Pharmaceutical Sciences Institute, Aston University, Aston Triangle, Birmingham B4 7ET.

ASTON UNIVERSITY

Department of Civil Engineering and Construction

RESEARCH STUDENTSHIPS

A limited number of Research Studentships will be available to British applicants with first or upper-second class honours degrees in a relevant science or engineering discipline who wish to undertake an MPhil or PhD by research in one of the following areas: Inorganic and Structural Materials, Systems and Remote Sensing, Water Resources, Transporation Planning, Construction Management.

Further information from: Dr C. L. Page, Post-graduate Admission Tutor, Department of Civil Engineering and Construction, Aston University, Aston Triangle, Birmingham B4 7ET. Tel 021 359 3611, Ext 4371.

UNIVERSITY OF LIVERPOOL

Department of Medicine

RESEARCH STUDENTSHIP

Applications are invited for a studentship tenable for three years from 1 April, 1986. The post is suitable for a graduate holding a first or second class honour's degree in Biochemistry or other relevant biological subject, who will be expected to register for a higher degree. The research will examine the mechanisms of action of Vitamin E in protection of skeletal muscle against various forms of damage.

Applications, together with a full cv and names of two referees, should be received as soon as possible by The Registrar, The University, PO Box 147, Liverpool L69 3BX. Quote Ref. RV/300/NS.

MORE VACANCIES ON PAGES 2–17

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

Chemistry Department

RESEARCH STUDENTSHIP

Applications are invited for a SERC CASE Research Studentship in co-operation with the British Gas Research Station, London. The work involves the measurement of gas sorption and transport in glassy polymers used in the development of membranes for the separation of gas mixtures.

The studentship is valued at normal SERC rates with an additional contribution from the Industrial sponsor.

Candidates should hold, or expect to gain, a First or Upper Second Class Honours degree in Chemistry or a related discipline.

Applications, including a cv and the names of two referees should be sent to Dr J. A. Barrie, Chemistry Department, Imperial College, London SW7 2AY.

THE UNIVERSITY OF LEEDS

DEPARTMENT OF PURE AND APPLIED ZOOLOGY

RESEARCH STUDENTSHIP

Applications are invited for a research studentship from those possessing or expecting to gain a first class or upper second class honours degree in Agricultural Zoology, Zoology, or an appropriate agricultural or biological science.

The studentship is tenable for two or three years (MPhil or PhD) and involves a confidential research initiative in biotechnology. The postgraduate will join a group based in the Zoology Department and he/she will co-operate closely with a postdoctoral worker and others involved in the project including Dr Diana Bowles (Biochemistry Department). The work will involve isolation and study of those nematophagous fungi that use lectins to recognise nematodes. Therefore an interest in fungi and/or nematodes would be of value.

Applications to Dr H. J. Atkinson, Department of Pure and Applied Zoology, The University of Leeds, LS2 9JT, with the names of three academic referees by 10 April, 1986.

BUSINESS OPPORTUNITIES

START AN IMPORT/EXPORT AGENCY from home, part- or full-time. No capital, no risk. Send 17p stamp for free 24-page booklet. Importexport Ltd, PO Box 334, London W5.

FOR SALE

South West Water Authority

has surplus analytical equipment for sale by tender.

Contact Laboratory Controller, Countess Wear Laboratory, Exeter EX2 7AA (Tel Exeter 34136).

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APPOINTMENTS WANTED

ZOOLOGY & MICROBIOLOGY GRADUATE, 25, typist, driver, wants interesting job. Box No D913.

HONS GEOLOGY GRADUATE (27) Presently South African Gold Mining, seeks challenging employment from July 86. C. Joynson, Box 904 Evander 2280 R.S.A.

FOUR HYDROBIOLOGISTS Available. Thinking of starting a new research group/department? We cover the full range of disciplines. Available now—just add water! (will separate.) Write for details. Box D912.

FELLOWSHIPS, GRANTS & SCHOLARSHIPS

UNIVERSITY OF EDINBURGH

DEPARTMENT OF BACTERIOLOGY

Faculty of Medicine Scholarship

Applications are invited for a three-year research scholarship to work on the characterisation of carbohydrate recognising receptors on mononuclear phagocytes. This will involve the use of various immunological and biochemical techniques to investigate the structure, and role of these receptors. The successful candidate will have (or attain this year) a first or second class honours degree in immunology, biochemistry, molecular biology or related subject.

Further information from, and applications (including cv and names of two referees) to Dr John Stewart, Department of Bacteriology, Medical School, Teviot Place, Edinburgh EH8 9AG (Tel 031-667-1011 Ext 2518).

UNIVERSITY OF ABERDEEN

Department of Chemistry

POSTDOCTORAL RESEARCH FELLOWSHIP IN FTIR SPECTROSCOPY

Applications are invited for an SERC Fellowship to undertake fundamental infrared spectroscopic research on widely diverse topics using a Nicolet 7199 Fourier Transform spectrometer. The position, which is tenable for up to two years, is open until 31 July, 1986, and involves up to 15 per cent commitment to research in other Scottish Universities. Starting salary in the range £7520-£8920 pa (under review), depending on qualifications and experience.

Applications with cv and names of two referees should be sent by 18 April, 1986 to Prof D. C. McKean or Dr J. L. Duncan, from whom further particulars may be obtained.

BROODBANK FELLOWSHIP

The Managers of the Broodbank Fund for the furtherance of research in Biochemistry or Biophysics with special reference to the Principles and Practice of Food Preservation give notice of their intention to elect Broodbank Fellows in May 1986. The tenure of the Fellowships will be from a date to be determined by the Managers in consultation with the Fellows, but normally 1 October, 1986. A Fellow will be required to carry out full-time research in a subject approved by the Managers.

Candidature is open, but preference will be given to postdoctoral applicants. A Fellow must normally become a member of the Superannuation Scheme. The tenure of a Fellowship, which will not normally exceed three years. will be determined by the Managers. The research work will be carried out in Cambridge (or in part elsewhere with Managers' consent) and will be subject to such conditions as the Managers may impose.

The remuneration of a Fellow is determined by the Managers according to a Fellow's experience and qualifications, within the range £7520-£10 330 (under review). In addition grants may be made by the Managers to cover expenses incurred by the Fellow in his or her work. A Fellow must inform the Managers of the award of any other emolument or of his or her intention to undertake work other than work approved by the Managers, and there may in consequence be a reduction in stipend. A Fellow may, with the permission of the Managers, undertake not more than six hours' teaching a week for remuneration without suffering any deduction from his or her stipend.

Applications (four copies) must be sent to Dr R. J. Stephensen, Secretary of the Managers of the Broodbank Fund, The Physiological Laboratory, Downing Street, Cambridge CB2 3EG, to reach him not later than 1 May, 1986. They must contain an outline of the candidate's proposed research, stating clearly how in the candidate's view this bears on the principles and practice of food preservation. They must name the Department or Institution willing to accommodate the research and must be accompanied by a statement of the candidate's career and date of birth, by copies of any paper he or she may have published or references thereto, and by the names and addresses of at least two referees. Not more than two testimonials may also be sent.

SILCOCK FELLOWSHIP
FOR LIVESTOCK RESEARCH

HARPER ADAMS AGRICULTURAL COLLEGE

Applications for this Fellowship are invited from persons over the age of 20 years for study or research into livestock husbandry and marketing. The Fellowship is valued at £5000 pa and is available for a period of up to 24 months dependent on the programme of study. This might be based on visits, surveys, literature reviews, experimental work or a combination of these. The successful applicant will be expected to produce a report for publication on completion of the Fellowship, and if eligible, will be given the opportunity to register for a further degree.

Closing date for entries will be 24 April, 1986.

Applicants should submit a cv and a letter of application outlining their proposed study or research programme to:

The Principal, Harper Adams Agricultural College, Newport, Shropshire TF10 8NB

UNIVERSITY OF BIRMINGHAM

Department of Space Research

Applications are invited for

TWO POSTDOCTORAL RESEARCH FELLOWSHIPS

in the Ionic Physics Group directed by Professor D. Smith and Dr N. G. Adams. The Group's interests are in fundamental studies of ionic reactions at thermal energies with special reference to reactions important in planetary atmospheres and the interstellar medium.

Both posts are tenable for up to three years.

Appointments will be on the Research Fellow 1A scale £8020-£12 780 plus superannuation.

For further particulars Tel 021-472 1301, Ext 2559, quoting reference number (E1/2).

No formal application. Three copies of application including full cv and naming three referees to Assistant Registrar (Science), PO Box 262, Birmingham B15 2TT by 18 April, 1986.

An Equal Opportunities Employer.

UNIVERSITY OF KENT

AT CANTERBURY

Royal Society Postdoctoral Research Fellowship in Fibre Optic Lasers

Applications are invited for a Research Fellowship to investigate fundamental aspects of fibre optic interferometric sensors and their application to the measurement of a diverse range of physical variables. Candidates should be well qualified in Physics or Electronics ideally with experience in modern optics. The appointment is initially for two years with the possibility of renewal. Salaries are in the range £8020-£11 275 on the Grade 1A scale. Application forms and further particulars may be obtained from the Assistant Registrar, Faculty of Natural Sciences, The Registry, The University, Canterbury, Kent CT2 7NZ. Closing date: Friday, 4 April, 1986. Please quote reference A13/86/N5.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

Department of Metallurgy & Materials Science in collaboration with the Building Research Establishment

CEGB RESEARCH FELLOWSHIP

Applications are invited for a three year Fellowship to study the durability of PFA concrete. The research work will be carried out at the Building Research Establishment, Garston, Watford, using the facilities of the Establishment's Laboratories which include electron microscopy, XRD and equipment to test engineering properties.

A First or Upper Second Class Honours Degree in Chemistry, Materials Science or a related subject, and a PhD or relevant research experience are essential.

Salary, inclusive of London Allowance in the range £9317-£14 077 pa.

Further particulars and application forms from Professor Peter Pratt, Department of Metallurgy & Materials Science, Imperial College of Science and Technology, Prince Consort Road, London SW7 2BP.

THE AUSTRALIAN NATIONAL UNIVERSITY
RESEARCH SCHOOL OF CHEMISTRY

PhD Research Scholarships

Applications are invited for research scholarships leading to the PhD degree in the following areas of Chemistry:

Organic Chemistry: *Professor A. L. J. Beckwith, Professor L. N. Mander, Mr R. W. Rickards, Dr J. K. MacLeod, Dr L. Radom*—Mechanistic and synthetic organic chemistry; chemistry and biochemistry of biologically active compounds; microbiological and marine chemistry; biomimetic reactions; reactive intermediates. Chemistry and biochemistry of DNA replication. Applications of ICR and mass spectrometry, and EST spectroscopy. Theoretical organic chemistry, *ab initio* molecular orbital theory; interstellar chemistry.

Inorganic Chemistry: *Professor B. G. Hyde, Professor A. M. Sargeson, Dr M. A. Bennett, Dr A. C. McLaren, Dr G. B. Robertson, Dr S. B. Wild*—Solid-state chemistry; mineralogy; electron microscopy/diffraction. X-ray crystallography, neutron diffraction. Synthesis, structure and mechanism of reactions of coordination complexes; biomimetic chemistry. Synthesis and catalytic properties of organotransition metal complexes. Resolution of chiral tertiary arsines and phosphines using metal complexes; macrocycles; asymmetric synthesis.

Physical and Theoretical Chemistry: *Professor J. W. White, Dr J. Ferguson, Dr R. Bramley, Dr L. R. Brown, Dr T. R. Welberry, Dr D. J. Evans*—Molecular and crystal spectroscopy by scattering methods, computer simulation, structure and spectroscopy of surface phenomena. Spectroscopy and photochemistry. Optical and magnetic resonance studies of photophysical processes; magnetic resonance in zero field. NMR spectroscopy, especially two-dimensional methods; distance-geometry calculations; structure and dynamics of biological and synthetic macromolecules. Optical analogue, X-ray diffraction and theoretical studies of disordered materials, particularly organic molecular crystals. Liquid state chemical physics.

Applicants for scholarships should be of high scholastic calibre with capacity for research, and hold, or expect to hold, a good honours degree or equivalent from a recognised university.

Basic Allowance: $Aust7167 per annum tax free. Approximate exchange rates at present are: $Aust1·00 = Stg 50p = $US 70c. A scholar may apply for family allowances. Return fares are normally paid; assistance with accommodation is given wherever possible.

Closing dates: 12 June 1986 and 31 October 1986. Applications may be made at any time.

For further information and application forms write, stating field of research, to Professor A. M. Sargeson, Dean, Research School of Chemistry, The Australian National University, GPO Box 4, Canberra, ACT 2601, AUSTRALIA.

UNIVERSITY OF SALFORD
Department of Chemistry and Applied Chemistry

POSTDOCTORAL RESEARCH FELLOWSHIPS

IN SOLID STATE ELECTROCHEMISTRY—CONDUCTING POLYMERS

Applications are invited for two postdoctoral fellowships in the electrochemistry laboratory from 1 May, 1986 in the following areas:

New Polymers with fast ionic and electronic conductivity
Thin film electrochemical studies of solid/solid interfaces

A special feature of the laboratory is experimental control and data acquisition by micro computers. Informal visits should be arranged by appointment with Dr J. Owen (Ext 604/615).

Salaries negotiable, according to experience, within the range £8020-£10 375 a year. In some cases travel allowances may be awarded for relocation of overseas staff and/or travel to conferences for presentation work.

Letters of application including cv and the names and addresses of two referees should be sent to the Registrar, University of Salford, Salford M5 4WT by 7 April, 1986 quoting reference CH/306/NS. Further particulars available from the Registrar (Tel 061-736 5843, Ext 215).

The Panasonic Trust

. . . gives financial help with courses fees for the further training of people working as engineers at graduate level, or near equivalent.

For further details contact:

THE FELLOWSHIP OF ENGINEERING
2 Little Smith Street London SW1P 3DL
Tel: 01-222 2688

NUFFIELD FOUNDATION

ONE YEAR SCIENCE RESEARCH FELLOWSHIPS

The Nuffield Foundation is offering to University and Polytechnic Lecturers in Science and Applied Science Departments a number of one-year research fellowships to be awarded competitively at the end of 1986 and to be held during the academic year 1987-88. The objective is to enable younger university lecturers to be freed from teaching and administrative duties for one academic year. Preference will be given to applicants under the age of 40. Awards will cover the cost of replacement teaching (up to the fourth point on the lecturer scale) and will include an allowance for research expenses.

The closing date is 1 October, 1986 and further particulars may be obtained from the Nuffield Foundation, Nuffield Lodge, Regent's Park, London NW1 4RS.

This scheme is open only to applicants from Institutes within the United Kingdom.

LECTURES, MEETINGS AND COURSES

THE BRITISH INDUSTRIAL BIOLOGICAL RESEARCH ASSOCIATION

GENERAL PATHOLOGY FOR TOXICOLOGISTS

There will be a two-week residential workshop designed to provide a broad background knowledge of pathology and its significance in general toxicology. The first week will commence on 19 May and the advanced part will commence on 10 November. It will be orientated towards participants with little formal knowledge of the subject and places will be limited to allow personal tuition.

The course fee is £1300 plus VAT for tuition, hotel accommodation and all meals.

For details please write to Prof K. R. Butterworth, BIBRA, Woodmansterne Road, Carshalton, Surrey SM5 4DS (Tel 01-643 4411).

UNIVERSITY OF STIRLING
Departments of Management Science and Economics

PhD RESEARCH

Applications are invited from scientists and engineers for work on:

waste re-cycling
inter-nation innovation and technology transfer
modelling of process plant availability
economics of machine translation
economics of robotization

SERC studentships may be available.

Details from:
M. Makower, FOR, F.INST Petroleum
Technological Economics Research Unit
University of Stirling
STIRLING FK9 4LA

SCOTTISH BUSINESS SCHOOL
STIRLING UNIVERSITY DIVISION

MORE VACANCIES ON PAGES 2—17

Thames Polytechnic

Incorporating Avery Hill College

MSC MOLECULAR SCIENCE OF MATERIALS

Study the Chemistry and Physics of Opto-electronic Materials and Displays.

Opportunities are available for project placements in Opto-electronics industries.

This one-year full-time course is supported by both the SERC and the Manpower Services Commission (TOPS).

Further details and application forms available from: Head of School, School of Materials Science and Physics, Thames Polytechnic, London SE18 6PF. Tel: 01-854 2030, Ext 282

NEW TECHNOLOGIES—FOR WAR OR PEACE? Scientists Against Nuclear Arms, Annual Conference. Manchester Town Hall, March 22 and 23. Join SANA—Join the debate. For details ring 01-871 3360.

LASER OPTICAL & SPECTROSCOPIC DIAGNOSTICS IN COMBUSTION

A course of 16 post-experience lectures will be held at IMPERIAL COLLEGE from 23-27 June, 1986. Details from Prof. F. J. Weinberg FRS, Dept. Chemical Engineering & Chemical Technology, Imperial College, London SW7 2BY.

Cranfield 40th Anniversary

New! B.Eng/BSc. Honours courses in INFORMATION TECHNOLOGY

Of special interest to sixth formers with a flair for Mathematics or the Sciences, this is an up-to-the-minute, exceptionally job-viable BEng/BSc Degree course designed to produce graduates with a broad and well founded knowledge of the creation and use of Information Systems for an ever widening range of commercial and defence applications.

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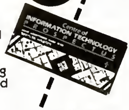

For further information and prospectus, please contact:
The Academic Registrar,
RMCS Shrivenham, Swindon, Wilts SN6 8LA
Tel: Swindon (0793) 782551 ext: 2402

Royal Military College of Science
SHRIVENHAM

IT/NS

I'm interested.

Name ____________

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Address ____________

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School of
Mechanical Engineering

Cranfield 40th Anniversary

ONE-YEAR MSc COURSE IN ENGINEERING MECHANICS MACHINE DESIGN

There is a continuing demand for good research and design engineers in, what could be loosely described as, the mechanical integrity side of industry. In particular, engineers with the capability of applying current Information Technology techniques to machine design and research, have a vital role to play. Some of the areas covered by the MSc courses listed above are:

- Finite Element Stress Analysis
- CAD Applications
- Tribology
- Turbomachinery Design
- Vibration Measurement
- Rotor Dynamics
- Engineering Plasticity and Shot-Peening
- Experimental Stress Analysis
- Machine Vibration Analysis
- Materials Technology
- Gear Design
- Laser Techniques and Signal Processing

For each of these areas there are excellent research facilities, usually supported with funds from Industry. Course entrants from Industry are encouraged to work on a research or design problem from their own companies, for their thesis project. In many circumstances the project can be carried out within the company.

These advanced courses commence early in October of each year. They are supported by both SERC and EITB

Please send further details and an application form for the courses.

NAME ....

ADDRESS ....

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....

• Complete the details • Clip the Ad • Post to:

Prof. Roy A. Cookson, (Ref. 1398), School of Mechanical Engineering, Cranfield Institute of Technology, FREEPOST, Cranfield, Bedford, MK43 7BR. Tel: Bedford (0234) 750111, Ext 2304

The University of Buckingham

MSc DEGREE IN FISHERIES BIOLOGY

Commencing October 1986

A one-year course for students holding a first degree in one of the Biological Sciences. The course covers the following topics: aquatic ecology, assessment biology, aquaculture with relevant courses in mathematics and statistics. There are also options in business studies, management, marketing and computing.

University bursaries are available towards the cost of fees. The University has also been allocated six Overseas Development Administration Scholarships which award free tuition, one return air-fare, a maintenance allowance, and an allowance for books and warm clothing.

For further details please contact the University, preferably by telephone, telex or cable, giving your full name and address, quoting reference NS.

The University of Buckingham, Buckingham MK18 1EG, UK. Tel: Buckingham (0280) 814080. Telex No. 826932 MKDCCI – mark telex "for attention of the University of Buckingham."

UNIVERSITY OF SOUTHAMPTON

MSc in Tropical and Sub-tropical Crops Research

Crops research is a multidisciplinary activity employing a wide range of techniques and requiring a broad understanding of biological and agricultural principles. This one year postgraduate course aims to give qualified scientists engaged in or co-ordinating research on tropical and sub-tropical crops a greater understanding of the various specialist research disciplines involved. this will assist them to a fuller understanding of the nature of their agricultural problems, to define them effectively and to devise efficient research strategies to overcome them. Newly qualified graduates would also benefit from this course before embarking upon a reserach programme.

Further information can be obtained from Dr P. J. Evans, Department of Biology, Building 44, The University, Southampton SO9 5NH.

MSc in Insect Pest Management

This is a high level MSc course, designed to teach a problem solving approach to insect and other agricultural pest problems. The course aims to satisfy requirements for training in two areas of particular relevance to modern pest control. Firstly, the development of rational control tactics that use pesticides in a selective way, compatible with other control measures and secondly the effective evaluation and development of pesticide and novel, biotechnological control measures to improve the long term efficiency of chemical pest control.

Further information may be obtained from Dr P. C. Jepson, Department of Biology and Chemistry, Building 3, The University, Southampton SO9 5NH.

Wolfson Institute of Biotechnology

PLANT CELL CULTURE—

from basic principles to biotechnology

University of Sheffield

A five-day intensive course covering the theory, practical techniques and applications of plant cell culture will be held at the Wolfson Institute of Biotechnology, University of Sheffield, from the 7th-11th July 1986. In addition to Wolfson Institute staff, the programme includes specialist speakers from the Department of Botany, University of Nottingham, and Rothamsted Experimental Station. The cellular and biochemical basis of the activities of cultured plant cells will be discussed in depth to facilitate rational experimental design and problem solving. This fundamental knowledge will then be applied to give a detailed appreciation of such specialist areas as somatic hybridisation, plant propagation, genetic transformation and secondary metabolite production, with special reference to the latest research results and future potential. Emphasis will also be placed on participants gaining the practical expertise necessary to establish a tissue culture facility, and a wide range of tissue culture materials and apparatus will be on display. The course is thus especially suitable for industrial personnel wishing to redirect their research effort towards plant material.

The course will be limited to 16 participants and the fee £395.

For further information contact: Dr G. S. Warren, Plant Cell Culture Course Organiser, Wolfson Institute of Biotechnology, The University, Sheffield S10 2TN, UK.

UNIVERSITY OF SURREY

UPDATE ON MOLECULAR MEDICINE

RECOMBINANT DNA & MONOCLONAL ANTIBODIES

24–25 September, 1986

A review of recent progress in the field, and its application to analytical, diagnostic and therapeutic use.

Topics: Recombinant DNA–genetic disease probes, new probe technology, factors VIII & IX, genetic finger-printing, histocompatibility, oncogenes, peptide hormones, protein production, new vaccines, engineering antibodies; **Monoclonal Antibodies**–electrofusion, ACTH immunometric assays, chemiluminescent assays, hormone receptors, cancer treatment, bacteriology, EBV antigens, blood group alloantigens.

Speakers: A. Malcolm (London, M. Brady (Amersham), E. Tuddenham (Royal Free Hosp), D. Werrett (CRE, Aldermaston), F. Grosveld (NIMR), G. Currie (Marie Curie Foundation), R. Craig (Middlesex Hosp), C. Hentschel (Celltech), F. Brown (Pirbright), A Duncan (Cambridge), B. Stace (Surrey), A. White (Manchester), I. Weeks (Cardiff), K. Siddle (Cambridge), K. Sikora (Cambridge), E. Wawrzynczak (ICRF), A. Coates (London), A. Morgan (Bristol), D. Anstee (Bristol).

Organisers: Peter Goldfarb and Ron Hubbard, Department of Biochemistry.

Registration Fee: £90, accommodation etc, available.

Closing date for reservations: 30 June, 1986.

Further information from: Mrs M. Lewis, Department of Biochemistry, University of Surrey, Guildford, Surrey.

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ARIADNE

THE GROUND sometimes shakes under the feet. After reading an Irish leader's remark that he had better get back to politics because it was the only way forward, I endeavoured to make a telephone call. It was a push-button instrument. The numbers ran 1, 2, 3, 4, 4, 6 etc. □

IT IS ALWAYS salutary to find that when you have spent time in ridiculing some apparently absurd gadget, it turns out to be sensible, efficacious and far-seeing. Crouched over the steering wheel, I have cackled in my semi-senile and superior way at motor cars ahead with extra lights fitted in the back window, perhaps in the form of the eyes of cats or tiny traffic lights that shine when the brakes go on.

Now, I am impressed by the sheer intelligence of the drivers concerned. For an extra light in the rear window, at eye level, is "the biggest safety breakthrough in the history of the US National Highway Traffic Safety Administration". Stringent government tests, states an advertisement for a third light kit, prove that the light reduces rear-end accidents by over 53 per cent.

My only quarrel was with the slogan used. "Amazing new third brake light can save your life." The quarrel was brief. After all, the facts certainly amazed me. □

SOME YEARS AGO, there was a bit of a row about subliminal techniques, by which messages or instructions could be flashed, for a split second, before a subject. For instance, a TV screen could be used to influence a viewer without anyone being aware of the methods being used. The conscious mind was unable to register the message because of its speed, but the unconscious mind could, and might be influenced by it. Uproar followed and smaller uproars have been heard occasionally since.

I thought that was the meaning of the word subliminal, but I find that it also indicates the influence on the unconscious that can be exerted by words, or syllables, in sequence or juxtaposition, and thereby hangs a commercial advantage or the reverse.

A coarse example or two may make this clearer, though they involve the conscious mind. You would, I should think, be well-advised to reject the name "Stikkit" for your first-class glue. If you are selling some product of integrity and your names are Wilson and Connolly you could probably do better than to telescope your names into Wilcon.

Mind you, I am interpreting what a firm running such a service to eliminate such dangers says about its activities and I hope I am doing it justice. It claims that it breaks down any name into its component parts and then "analyses the subliminal value of each in relation to the others".

What I am slightly puzzled about is how the subliminal value is arrived at in the first place, especially as the assessments are made "without the clouding effect of conscious thought, cutting through possible emotive colouring", whatever that might signify. Presumably, the firm's own name for the service, computer aided, went through the subliminal mill before being chosen.

It is Sub-Fax. □

If they make you dig a hole at least they could give you a proper toilet-roll holder

POLITICIANS are notorious for putting on a brave show when faced with caricatures and lampoons of themselves, even going so far as to pay out money for copies and laughing at the same time. Just one of the lads, really, a good sort, you are encouraged to conclude, though the sentiment may hardly go well with the note of strain in the laughter. There must be a politicians' school somewhere in which self-deprecating smiles and chuckles are taught to ministers and members. "No Margaret, lift up the corners of the mouth. You're trying to show you're *amused*." "Come on, Neil, that's more of a rictus than a roar."

Being the subject of impressions must cause pain and outrage to those lacking humour, too. I have heard the ingenious theory that Thatcher continually changes her voice so that mimics are always one voice behind and are therefore never quite accurate. It would help to assuage wounded feelings, I suppose, and make bogus chortles easier to achieve. □

BY COINCIDENCE, I was reading a recipe for garlic soup. A couple of days later I was in it. Just before Christmas last year I made some mildly sceptical remark about a claim that garlic had anti-cancer properties, the report of the activity coming from China.

For that, I have now been roundly ticked off by a researcher at the English College in Valladolid in Spain. His letter is eloquent about the virtues of garlic or garlic extracts. According to it, garlic can relieve asthma and bronchitis and may also be useful in combatting thrombosis by changing the proportion of high-density lipoproteins to low-density ones in blood plasma.

The Chinese and Japanese, says David Greenstock, who wrote the letter, have done good work on garlic research, which the West has been reluctant to accept. He also says that it is a fact that garlic can ward off the common cold, proved by experiments in Europe and Canada, which is news to me.

Greenstock maintains that this magazine, like other institutions, suffers from bias against anything that is outside the bounds of "official" medicine. It may. I am not competent to say. What I am certainly competent to say is that it is pointless to argue, as he does in support of the anti-cancer revelations, that, as the Chinese discovered gunpowder long before anyone else, it would not be surprising if they "have come up with the inhibition of the nitrosamines by the use of garlic extracts". That is a non sequitur, all right. □

THE CONVENTIONAL sleeve bearing conceals much subtlety. The rotating shaft entrains and forces its lubricant into the very region where it might touch and seize the outer sleeve under its load. It is the hydrostatic pressure pumped into the region that floats the shaft in its sleeve.

Daedalus sees a novel motor in all this. The oil reaches very high temperatures and pressures in the loaded region. If oxygen were dissolved in it, or suspended as tiny bubbles, the diesel-effect compression should cause combustion in the oil. As it emerged from the region, charged with hot gas, the oil should expand in Wankel-engine fashion, entraining the shaft by its viscosity and speeding it up.

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The new bearings will even power reciprocating or irregularly moving shafts, accelerating any movement once it has begun. So simple oil-burning sewing-machines and typewriters will be possible, as well as elegantly power-assisted steering racks, shears and pruning cutters, guillotines and folding beds and self-closing doors.

But effective dampers and end-stops would be needed, or these humble objects might easily be set into sustained racketing oscillation, until their oil supply ran out and they seized solid. □

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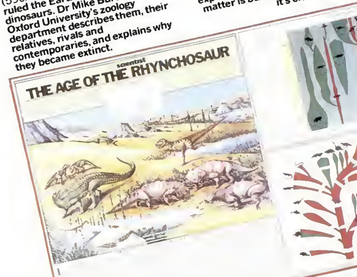

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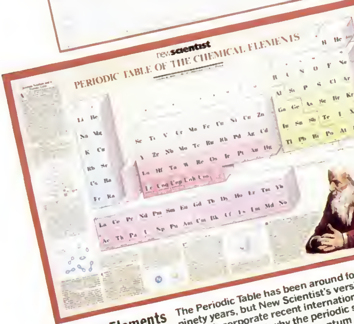

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